VPR-2B

VIDEO PRODUCTION RECORDER

THEORY AND
MAINTENANCE

1809477
AMPEX

Ampex Corporation

Catalog No. 1809477-01
Issued: August 1981
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VPR-2B
VIDEO PRODUCTION RECORDER

THEORY AND MAINTENANCE

AMPEX CORPORATION
AUDIO-VIDEO SYSTEMS DIVISION

Prepared by

AVSD Technical Publications
Ampex Corporation
401 Boradway
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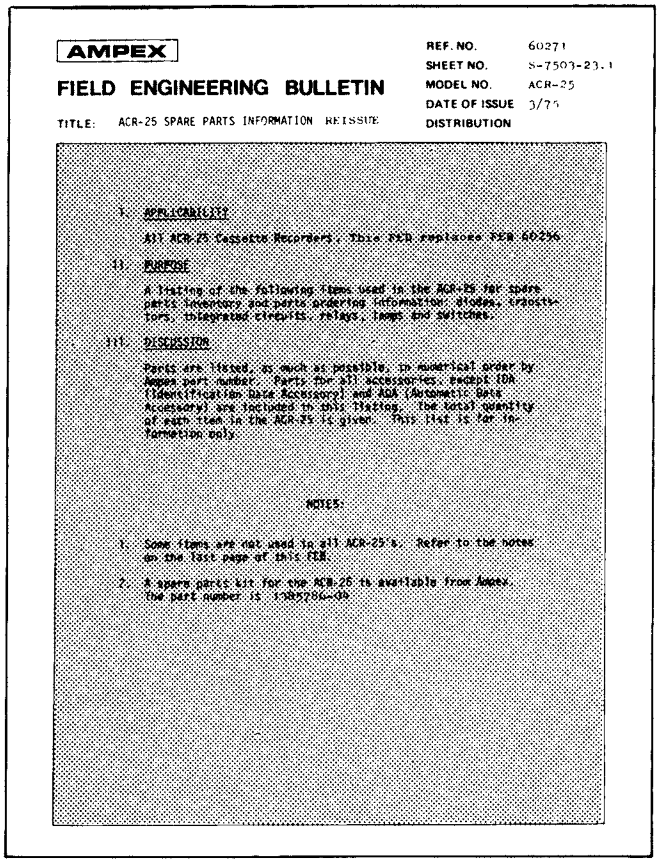

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FIELD ENGINEERING BULLETIN

REF. NO.	60271
SHEET NO.	S-7503-23.1
MODEL NO.	ACR-25
DATE OF ISSUE	3/75
DISTRIBUTION	

TITLE: ACR-25 SPARE PARTS INFORMATION REISSUE

I. APPLICABILITY

All ACR-25 Cassette Recorders. This FEB replaces FEB 60256

II. PURPOSE

A listing of the following items used in the ACR-25 for spare parts inventory and parts ordering information: diodes, transistors, integrated circuits, relays, lamps and switches.

III. DISCUSSION

Parts are listed, as much as possible, in numerical order by Ampex part number. Parts for all accessories, except IDA (Identification Data Accessory) and ADA (Automatic Data Accessory) are included in this listing. The total quantity of each item in the ACR-25 is given. This list is for information only.

NOTES:

1. Some items are not used in all ACR-25's. Refer to the notes on the last page of this FEB.
2. A spare parts kit for the ACR-25 is available from Ampex. The part number is 1385786-04

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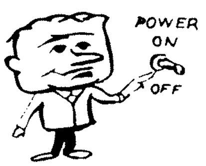
Effective: 1 October 1980

SAFETY AND FIRST AID SUGGESTIONS

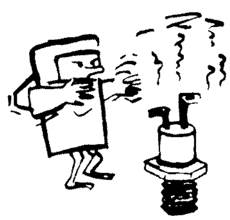
Regardless of how well electrical equipment is designed, personnel can be exposed to **dangerous electrical shock** when protective covers are removed for maintenance or other activities. Therefore, it is incumbent on the user to see that all safety regulations are consistently observed and that each individual assigned to the equipment has a clear understanding of first aid related to electrical hazards.

In addition, the following safety practices must be followed:



1 Do not attempt to adjust unprotected circuit controls or to dress leads with power <u>on</u>.

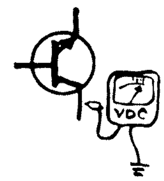
2 Do not touch heavily loaded or overheated components without precaution to avoid burns.

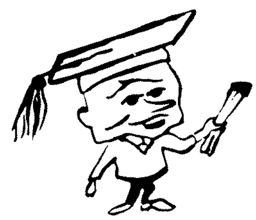


3 Do not assume that all danger of electrical shock is removed when power is <u>off</u>. Charged capacitors can retain dangerous voltages for a long time after power is removed. These capacitors should be discharged through a suitable resistor before any circuit points are touched.

4 Always avoid placing parts of the body in series between ground and circuit points.

5 Remember that some semiconductor cases and solid-state circuits carry high voltages.





6 Don't take chances. Be fully trained. Ampex equipment should be operated and maintained only by fully qualified personnel.

If someone seems unable to free himself while receiving an electrical shock, **turn power off** before attempting to render aid. A muscular spasm or unconsciousness can make a victim unable to free himself from the electrical power.

WARNING

DO NOT
TOUCH VICTIM OR HIS CLOTHING BEFORE
POWER IS REMOVED OR YOU MAY ALSO
BECOME A SHOCK VICTIM

If power cannot be removed immediately, **very carefully** loop a length of dry nonconducting material (such as rope, insulating material, or clothing) around the victim and pull him free of the power. Carefully avoid touching him or his clothing until free of power. Immediately start the appropriate first aid procedures.

GOOD PRACTICES

In maintaining the equipment covered in this manual, please keep in mind the following standard good practices:

1. When connecting any instrument (oscilloscope, waveform monitor, etc.) to a high-frequency output, use the appropriate termination resistor at the input of the instrument, unless the instrument is terminated internally.

2. When inserting or removing printed wiring assemblies (PWAs), cable connectors, or fuses, always turn off power to the affected portion of the equipment. After power is removed, allow sufficient time for the power supplies to bleed down before reinserting PWAs.

3. When troubleshooting, remember that FETs and other metal-oxide-semiconductor (MOS) devices may appear defective because of leakage between traces or component leads on the printed wiring board. Clean the printed wiring board and recheck the MOS device before assuming it is defective.

4. When replacing MOS devices, follow standard practices to avoid damage caused by static charges and soldering.

5. When removing components from PWAs (particularly ICs), use care to avoid damaging PWA traces.

WARNING

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. As temporarily permitted by regulation it has not been tested for compliance with the limits for Class A computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

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VPR-2B Video Production Recorder

SECTION 1

GENERAL SYSTEM INFORMATION

1-1. SCOPE OF MANUAL

This theory and maintenance manual provides documentation for the Ampex VPR-2B Video Production Recorder. When used with the VPR-2B Parts Lists and Schematics Manual, Ampex Catalog Number 1809472-01, this manual provides information needed for maintaining and repairing the VPR-2B. This manual applies to NTSC, PAL, PAL-M, and SECAM versions of VPR-2B. The material is organized as follows:

Section 1 – Contains general infromation about VPR-2B, such as capabilities, physical description, and interface considerations.

Section 2 – Contains the theory of operation; explains how VPR-2B works down to a circuit-by-circuit level. Block diagrams are provided.

Section 3 – Provides complete maintenance information. Material is divided between preventive maintenance and corrective maintenance.

1-2. INTENDED USE

The VPR-2B is a 1-inch, one-field-per-scan, helical teleproduction recorder with a 90-minute record/play time. The VPR-2B can utilize all features provided for in the SMPTE Type C and EBU format C specification for 1-inch helical scan video tape recordings, and can be used with 525-line/60-Hz or 625-line/50-Hz monochrome or NTSC/PAL/SECAM/PAL-M color systems.

1-3. CAPABILITIES

Some of the features and capabilities of the basic VPR-2B are listed below:

1. Three audio channels, all capable of full bandwidth record and playback operations.
2. Variable speed shuttle, providing up to 300 in/s (762 cm/s) (X 30 normal) speed in forward and reverse.
3. Variable speed play, from still to approximately one and one-quarter play speed forward and one-quarter play speed reverse.
4. Color framer, for minimizing horizontal picture shift during editing or switching.
5. Autochroma, for automatically adjusting playback equalization control on a field-by-field basis.
6. Tape timer, providing digital display with one-frame accuracy.
7. Search and edit systems, providing complete automatic editing capability, including programmable entrance and exit edit points, as well as multi-VPR-2B edit control and rehearsal features. Spot erase for audio channels is also provided.
8. Video meter, providing monitoring of VPR-2B incoming video, or monitoring of video or sync rf from tape during record or playback.

1-4. Additional Capabilities

Additional capabilities are those features added or enhanced through the use of optional or accessory equipment.

1-5. Capabilities with VPR-2B Options. Additional operational capabilities are provided when the VPR-2B is equipped with the following options:

1. AST Kit. When equipped with the (AST) [1] (Automatic Scan Tracking) option, the video play head is capable of mechanical transverse deflection. This ensures accurate tracking of recorded video material and, when used in conjunction with the Ampex TBC-2B Time-Base Corrector, provides slow motion, still-mode, and forward/reverse slow motion playback without picture disturbances. It additionally provides simultaneous video playback during record mode for video record confidence.

2. Sync Kit. When equipped with the sync channel option, all vertical interval information can be recorded according to the Type C format.

3. Four-Channel Audio Kit (EBU Format C). When equipped with the four-channel audio option, a fourth audio channel is provided on the track space otherwise allotted to the sync channel. Channels three and four are time coincident with the other audio channels.

1-6. Capabilities with VPR-2B Accessory Equipment. Additional capabilities provided by available accessory equipment are listed below:

1. A remote control panel, permitting remote control of VPR transport, editor, setup, and control functions at distances up to 100 meters.

2. An SMC-100 Slow Motion Controller, providing remote and expanded control of VPR transport functions. It also includes two manually controllable cue points used in conjunction with the SMC-100 front panel clock display.

3. An STC-100 Multipoint Search-to-Cue provides up to 99 auto cue points for either record or play. It serves to improve and expand a studio's sports coverage and spot commercial playback. It can also permit recording of up to 99 still recordings, each with its own cue point. Power down memory is included.

4. An HPE-1 Production Editor, providing single-location editing control for up to four VPR series recorders. Features and options include an automated programmable voice-over editor, an EBU time-code reader, an adjustable pre-roll increment, and joystick control of VPR transport functions.

5. A rack-mountable color corrector, providing a color picture (for non-broadcast use) when the VPR is not used with a time-base corrector.

6. A TBC-2B Time-Base Corrector, providing a broadcast quality color video signal from the VPR-2B.

7. A Time-Code Reader/Generator, providing an internal VTR time-code reader and generator.

8. A Character Generator, providing monitor screen display of the accessory time-code reader/generator's output data.

1-7. PHYSICAL DESCRIPTION

The major assemblies which make up the VPR-2B are shown in Figure 1-1. The following paragraphs describe the physical characteristics of each of these assemblies.

1-8. Transport Assembly

The transport assembly (Figure 1-2) consists of a top plate and all tape handling and head subassemblies for the recorder. Clamshell covers are hinged to provide access to the tape threading path and to protect the transport components. In Figure 1-2, the clamshell covers and other protective covers and trim have been removed so that major transport assembly components are visible.

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[1] T.M. Ampex Corporation

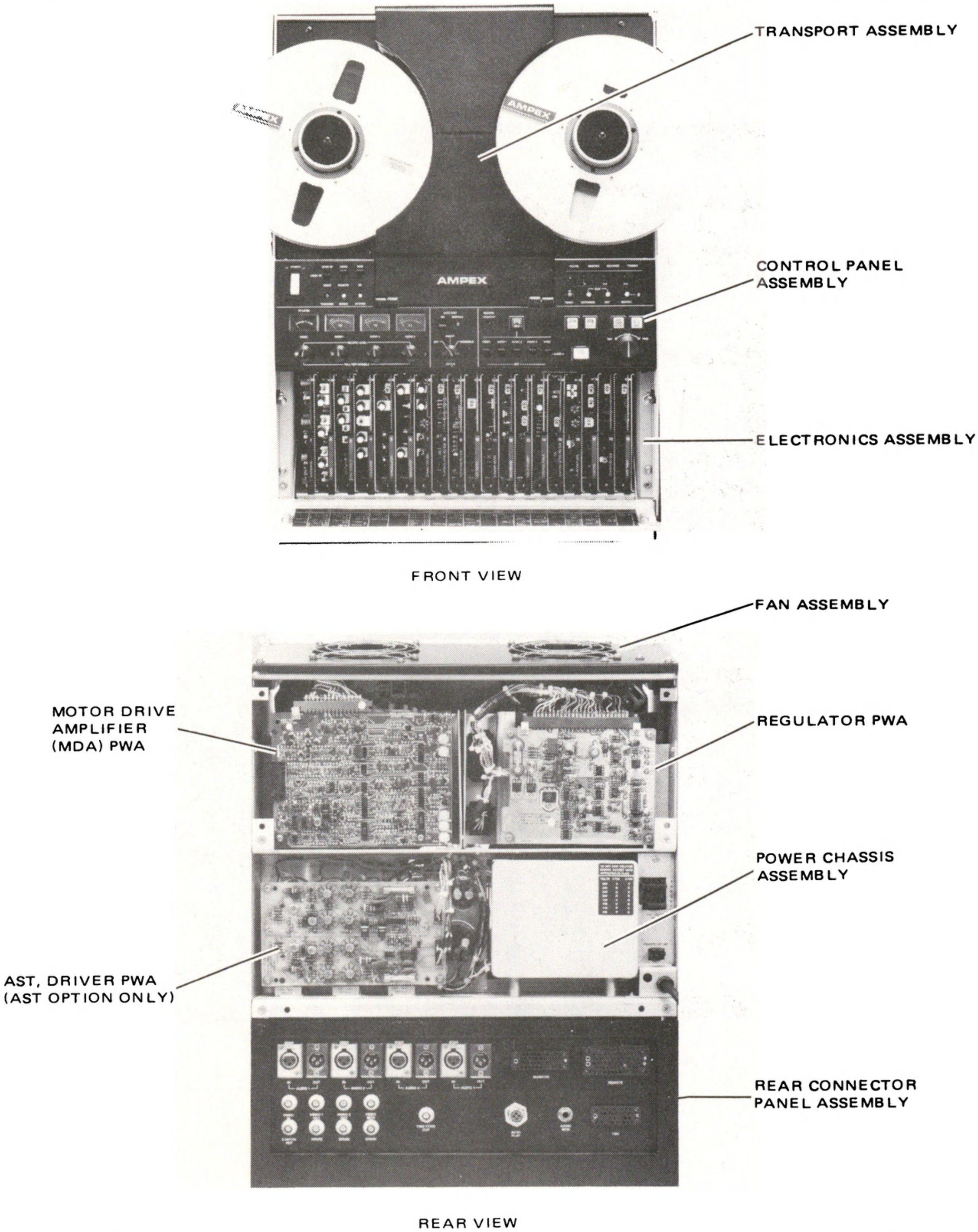


Figure 1-1. VPR-2B Major Assemblies

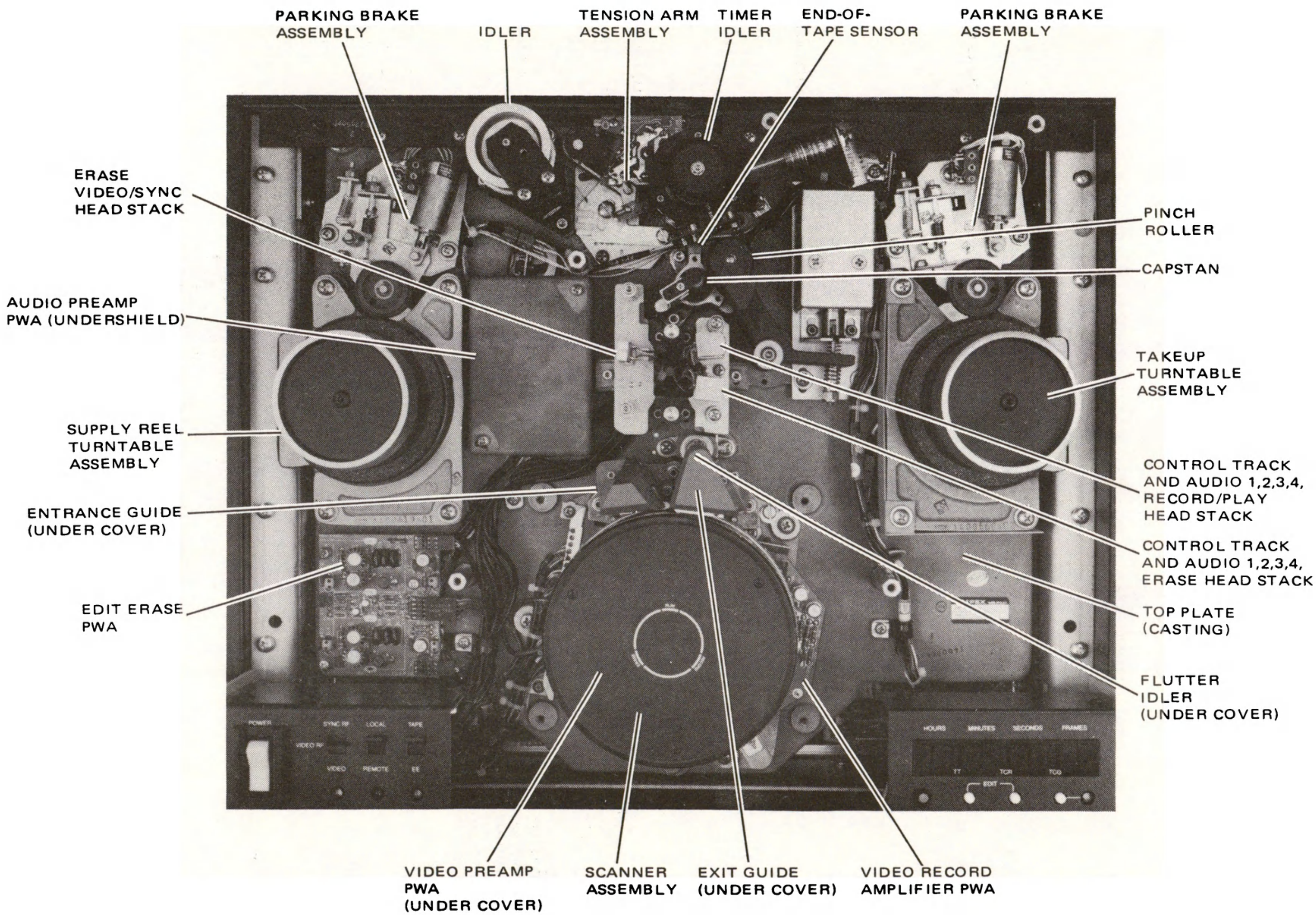


Figure 1-2. Transport Assembly

1-9. Top Plate. The top plate is a ribbed, aluminum alloy casting upon which the transport subassemblies are mounted. The subassemblies are attached with machine screws to precision ground, threaded bosses on the baseplate. All subassemblies, with the exception of the capstan motor and flutter idler, are removable from the front side of the top plate.

1-10. Tape Handling Subassemblies. The subassemlbies described below move and guide the tape through the threading path.

1-11. *Reel Motors.* Reversible dc motors are used to drive the supply and takeup reels. Tape reels are secured with hold-downs on the reel motor turtables.

1-12. *Tape Idlers, Rollers, and Guides.* Tape emerging from the supply reel first encounters the idler, a rigidly-mounted, large-diameter roller which alters the tape direction and provides initial edge guiding. The tape then conacts the tension arm subassembly, which senses tape tension. A set of two guides, located on each longitudinal head subassembly, positions the tape against the heads. The entrance and exit guides (part of the scanner assembly) provide proper positioning of the tape at the entrance to, and exit from, the scanner guide band. A flutter idler between the exit guide and right-hand audio stack isolates video head tip disturbance from the audio head stack. Tape is held in contact with the capstan by the pinch roller, which is engaged by a solenoid during play, record, still-mode and slow-motion modes of operation. The timer idler alters tape direction toward the takeup reel.

1-13. *Capstan.* The capstan, which is belt-driven by a servoed dc motor, controls tape speed. An optical tachometer supplies capstan speed information for the servo. During record operations, the capstan determines track spacing. During playback, the capstan ensures accurate alignment of recorded tracks to the video head, with timing information being taken from the control track.

1-14. Tape Timer Idler with End-of-Tape (EOT) Sensor. The tape timer idler is rotated by tape motion. A two-channel concentric tachometer disk is used to provide tape timing information. An end-of-tape (EOT) sensor is an integral part of the tape timer idler assembly. The EOT sensor provides a signal that initiates dynamic reel braking when tape runs off transport.

1-15. Parking Brakes. The parking brake solenoids are energized during active modes of operation and are de-energized to apply brakes to the turntable of both reel motors during stop or when primary power to the VPR is interrupted.

1-16. Scanner Assembly. Major components of the scanner are a servo-controlled dc motor, a stationary lower drum, a rotating upper drum, and entrance and exit tape guides. The scanner has positions for six heads in accordance with Type C format specifications. The basic (non-sync) scanner contains three active video heads (edit erase, record, and playback) spaced at 120° intervals, and three dummy heads. When the sync channel option is installed, the dummy heads are replaced by sync channel erase, record, and playback heads. If the AST option is installed, the standard video playback head is replaced by a special AST playback head. All six heads are easily replaceable. The scanner also contains rotary transformers to transfer signals between the rotary and stationary elements of the scanner assembly.

1-17.. Longitudinal Heads. Two longitudinal head assemblies are mounted on the tape transport (see Figure 1-2). The left-hand assembly is the video/sync erase assembly. The right-hand assembly consists of two head stacks: the first stack consists of erase heads for each of the audio channels and a head for control track erase; the second stack has record/playback heads for each of the audio channels, and another record/playback head for the control track.

1-18. Control Panel Assembly

Primary operating controls and indicators are located on the control panel assembly. The panel is divided into five sections, with controls and indicators grouped according to general function.

The sections are: control and monitoring, level adjust and metering, record/edit, mode select, and tape timer.

1-19. Electronics Assembly;

The electronics assembly consists of a motherboard/wiring assembly with 19 printed wiring assembly (PWA) connectors, mounting hardware, and a complement of up to 19 PWA's. The quantity of PWA's, and their part numbers, depends upon the options selected. Secondary operating controls and indicators are located on the front edges of the PWA's. A hinged door on the front of the electronics assembly provides access to these PWA's. Table 1-1 provides locations and identification of PWA's.

1-20. Motor Drive Amplifier (MDA) Assembly

Drive voltages for all motors (reel, capstan, and scanner) on the tape transport are provided by the MDA assembly. The assembly consists of three subassemblies: a main PWA, a secondary PWA, and a heat sink subassembly.

1-21. Power Chassis and Regulator Assemblies

The power chassis and regulator assemblies provide the voltages necessary for VPR operation. The power chassis assembly consists of a transformer, capacitors, and rectifiers, producing unregulated dc voltages from the ac primary power input. It also contains an easily accessible line voltage selector. The regulator assembly consists of a Regulator PWA and a heat sink subassembly.

1-22. Automatic Scan Tracking (AST) Drive Assembly

The AST driver assembly is part of the optional AST kit. It provides drive voltages to the AST head in response to signals from the AST servo.

1-23. Fan Assembly

The fan assembly provides cooling for the internal components of the VPR' It consists of a mounting panel and two fans.

1-24. Connector Panel Assembly

The connector panel, part of the electronics assembly, contains all VPR input and output connectors except ac line and console power.

1-25. FUNCTIONAL DESCRIPTION

Figure 1-3, the Overall System Block Diagram, illustrates the basic system configuration for the VPR-2B. A brief description of each of the blocks is given below.

NOTE

Reference to a PWA (Printed Wiring Assembly) as a front panel PWA indicates that it is located in a front slot of the electronics assembly. The electronics assembly is located directly below the VPR control panel. Access to front panel PWA's is via a hinged front cover.

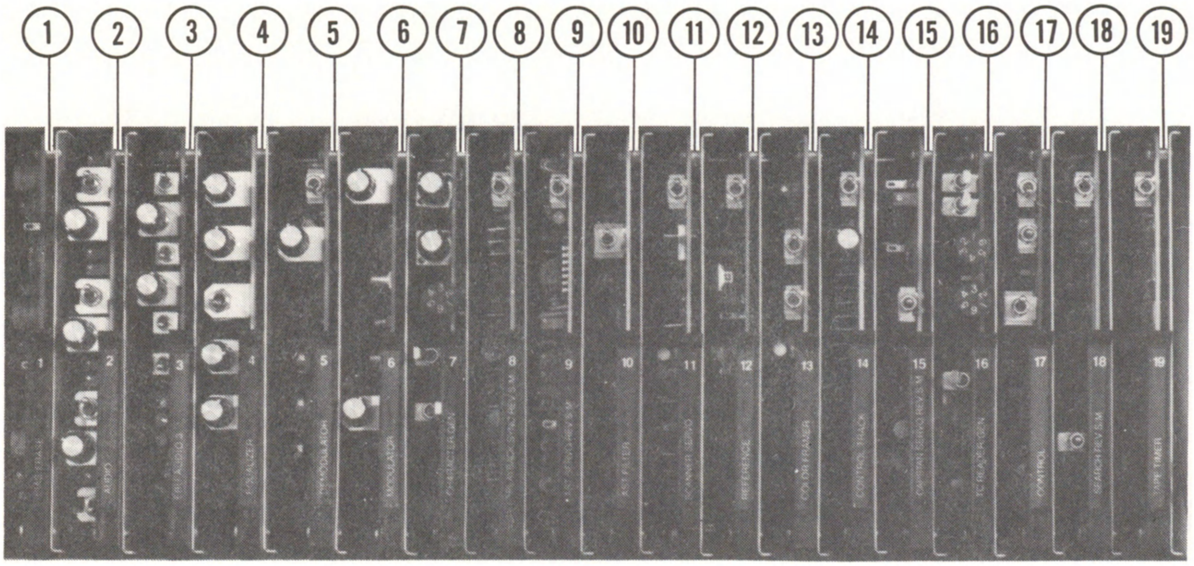
1-26. Audio

The audio section contains a maximum of seven PWA's which provide interface and processing for all audio and cue signals. Included in the audio section are up to three front panel PWA's, and four other PWA's.

1-27. Bias/Erase PWA. The Bias/Erase PWA occupies position 1 of the electronics assembly. This PWA contains drivers that supply bias and erase current for three audio channels, erase current for the control track, and video/sync erase head drives. In addition, meter driver amplifiers supply vu or ppm (peak program meter) signals to the audio meters.

1-28. Audio PWA. The Audio PWA occupies position 2 of the electronics assembly. This PWA includes audio signal processing amplifiers for both

Table 1-1. Electronics Assembly PWA Locations



INDEX NO.	PWA NAME	PART NUMBERS		
		NTSC	PAL/SECAM	PAL-M
1	Bias Erase	1400013	1400013	1400013
2	Audio (•)	1400020	1400020	1400020
		1400026	1400026	1400026
3	EBU Audio 3 (option)	1400033	1400033	1400033
4	Equalizer (Sync Option)	1400040	1400043	1400040
	Equalizer (w/o Sync Option)	1401040	1410143	1401040
5	Demodulator	1400050	1400053	1400050
6	Modulator	1400060	1400063	1400060
7	Video Bypass	1401070	1401070	1401070
	Character Generator (Accessory)	1400073	1400073	1400073
8	Playback Sync (AST Option)	1400086	1400086	1400086
	Playback Sync (Non-AST	1400083	1400083	1400083
9	AST Servo (AST Option)	1400093	1400093	1400093
10	AST Filter (AST Option)	1400100	1400100	1400100
11	Scanner Servo	1400113	1400113	1400113
12	Reference	1400123	1400123	1400123
13	Color Framer	1400130	1400133	1400136
14	Control Track	1400140	1400146	1400140
15	Capstan Servo	1400153	1400153	1400153
16	T.C. Reader/Generator (Acc)	1400160	1400160	1400160
17	Control	1400176	1400176	1400176
18	Search	1400183	1400183	1400183
19	Tape Timer	1400190	1400190	1400190

(*) Two functionally identical versions of the Audio PWA exist.

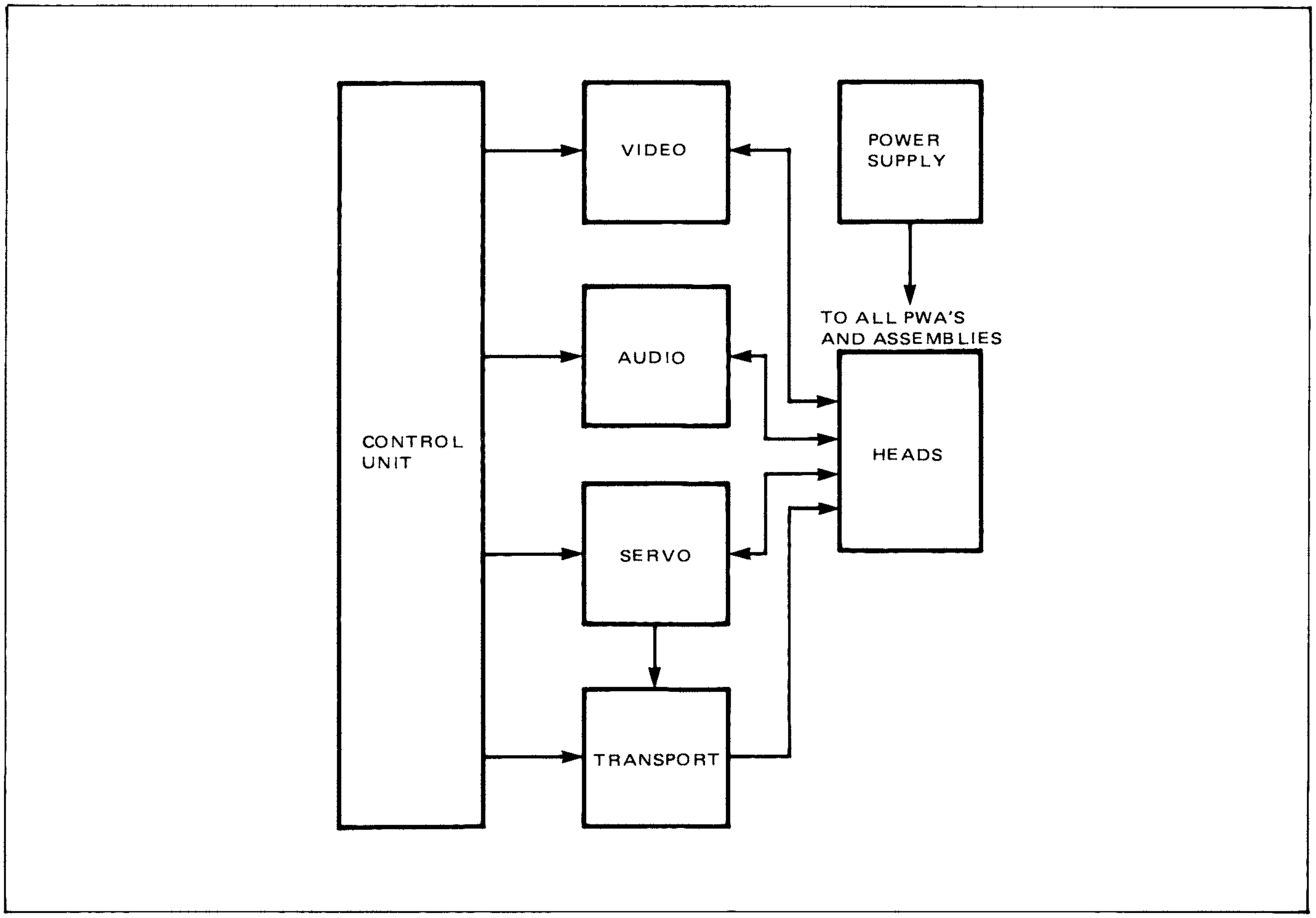


Figure 1-3. Overall System Block Diagram

record and play modes. Three channels are represented, with microphone/line/time-code capabilities available for channel 3/4.

1-29. EBU Audio 3 PWA. The EBU Audio 3 PWA is supplied only as a part of the four-channel audio option and occupies position 3 of the electronics assembly. This PWA includes record/play audio signal processing amplifiers and bias/erase drive signals for the EBU audio 3 channel.

1-30. Audio Preamp PWA. The Audio Preamp PWA is mounted on the transport chassis to the left of the head assemblies. A shield secured by two screws must be removed for access to the PWA. It provides low level preamplification for off-tape audio-channel play signals, directly from the record/play heads. Relay switching of record signals to the heads is also provided.

1-31. Audio I/O PWA. The Audio I/O PWA is mounted on the inside of the rear connector panel. This PWA provides input coupling and amplification for three balanced audio line inputs. Additional amplification is provided for channel 3/4 when used in the microphone mode. Output coupling transformers are furnished between the line drive signals and the line output connectors on the rear connector panel.

1-32. Line Driver PWA. The Line Driver PWA is located behind the electronics assembly motherboard, near the rear connector panel. This PWA contains amplifier stages which provide

audio-monitor output and line level drive signals. The monitor output signals are routed to the rear connector panel, while the line drive signals are directed to the Audio I/O PWA. In addition, audio meter signals are derived via active rectifier circuitry.

1-33. Audio Level PWA. The Audio Level PWA is mounted inside the control panel, toward the left side. This PWA provides for operator control of audio record levels for three channels. Buffer amplifiers are included between the controls and subsequent routing to the Audio PWA.

1-34. Video

The video section contains seven PWA's which provide interface and processing for the video signals. Included in the video section are four front panel PWA's, and three other PWA's.

1-35. Equalizer PWA. The Equalizer PWA occupies position 4 of the electronics assembly. The major function of the PWA is to equalize rf signals from the video and sync play heads, then route the signals to the demodulator. In addition, the Equalizer PWA furnishes record head, video play, and sync PWA. Two versions of the Equalizer PWA exist to accommodate both sync option and standard VPR-2B models.

1-36. Demodulator PWA. The Demodulator PWA occupies position 5 of the electronics assembly. This PWA demodulates and amplifies one of two incoming rf signals: either tape rf from the equalizer, or EE rf from the modulator. Three output video signals are produced and routed to a rear connector panel. The incoming signal choice is determined by an EE/TAPE command.

Other PWA functions include rf dropout detection, generation of a monitor sync signal, and generation of auto chroma error and color/mono signals to be used by the Equalizer PWA.

1-37. Modulator PWA. The Modulator PWA occupies position 6 of the electronics assembly. The major function of this PWA is to frequency-modulate a carrier frequency with the incoming video signal. Pre-emphasis is applied to the signal, as well as additional amplification during the burst interval. In addition, the PWA provides video meter drive circuitry and video/sync record current signals.

1-38. Video Bypass PWA. The Video Bypass PWA occupies position 7 of the electronics assembly. This PWA presently contains a coaxial jumper connection between the demodulator outputs and the I/O panel. It is replaced by the optional Character Generator PWA when present.

1-39. Record Amplifier PWA. The Record Amplifier PWA plugs into the lower portion of the scanner assembly. In record mode, this PWA amplifies the rf signal from the modulator, then directs this signal to the video record head (and sync record head, if so equipped). During edit play mode an rf play signal is received from the video record head, amplified, then directed to the equalizer. Two versions of this PWA exist to accommodate both sync option and standard VPR-2B models.

1-40. Video Preamp PWA. The Video Preamp PWA is mounted on the upper (rotating) portion of the scanner assembly. This PWA contains two channels of preamplification, one for the video play head rf signal, the other for the sync play head (if so equipped).

1-41. Edit Erase PWA. The Edit Erase PWA is mounted on the tape transport. This PWA provides erase oscillator current to the video edit erase and sync edit erase heads in the upper portion of the scanner.

1-42. Servo

The servo section contains up to nine PWA's which provide regulation over tape travel, scanner head rotation, tape tension, and, in the AST option, transverse video play head position. Included in the servo section are eight front panel PWA's, and one other PWA.

1-43. Playback Sync PWA. The Playback Sync PWA occupies position 8 of the electronics assembly. Two versions of this PWA exist to accommo date both AST and non-AST models.

The Playback Sync PWA generally provides the portion of off-tape video signal processing that is not directly involved in the derivation of VPR-2B video outputs. This processing includes: generating meter drive signals, developing most of the TBC interface signals, supplying dropout interval information, providing video/sync head switching commands, and supplying off-tape vertical sync.

1-44. AST Servo PWA. The AST Servo PWA is supplied only as a part of the AST option, and occupies position 9 of the electronics assembly. This PWA operates in conjunction with the AST filter and AST driver to control the position of the AST head. Specifically, this PWA derives an AST servo error signal from the reproduce RF signal. This signal is then processed according to the chosen play mode (normal play, slow motion, or still mode). Also included on the PWA is a low level amplifier for the AST driver, and a modulating dither generator providing oscillatory motion of the AST head.

1-45. AST Filter PWA. The AST Filter PWA is supplied only as a part of the AST option, and occupies position 10 of the electronics assembly.

This PWA provides gating, frequency division, delay, and signal filtering for the AST servo system. Ac/dc gate generator circuits provide the basis for error signal switching within the servo loop. A divider circuit provides a 450-Hz (525) or 425-Hz (625) dither generator frequency from a 64H Reference PWA signal. A variable delay circuit ensures that, if the AST head must be moved to an adjacent track, the move will take place during the vertical dropout interval. A comb filter is also provided to maximize error signal gain at certain frequencies.

1-46. Scanner Servo PWA. The Scanner Servo PWA occupies position 11 of the electronics assembly. The main function of this PWA is to control the velocity and phase of the scanner motor in all modes of operation. To accomplish this task, velocity and position servo loops are employed. The velocity loop compares scanner tach signals with a ramp derived from the previous tach signal. In the position loop, the scanner tach signal is phase locked to a floating tach reference. The output of these servos is summed and routed to the MDA (Motor Drive Amplifier), where it is amplified to drive the scanner motor.

1-47. Reference PWA. The Reference PWA occupies position 12 of the electronics assembly. This PWA primarily provides two functions for the VPR. The first funtion includes the providing of all sync related frequencies required to operate the VTR. Second, the PWA generates video related record commands for video and sync channels. Also included is a card-edge thumbwheel which allows adjustment of servo/TBC lead for up to 7-1/2 TV lines.

1-48. Color Framer PWA. The Color Framer PWA occupies position 13 of the electronics assembly. This PWA provides 1/4 and 1/2-frame reference signals to the Control Track PWA. One of these signals (depending upon the color system), together with the operator adjustments on the Color Framer PWA card edge, allows identification and phase control of color frame/sync sequences. One effect is the minimization of horizontal picture shift. This shift might otherwise result from edits in which the VTR does not vertically lock to the proper color frame sequence of the input video signal. Color detection is also provides, shutting down the color system in the presence of monochrome signals.

1-49. Control Track PWA. The Control Track PWA occupies position 14 of the electronics assembly. This PWA provides all circuitry needed to operate the control track head. The circuitry includes a coded 30-Hz (25-Hz) record signal generator, a variable tracking play reference amplifier, and phase error amplifiers. The control track signal includes color frame identification pulses. These pulses occur at a 15-Hz (6-1/4-Hz) rate.

In addition, this PWA supplies control track position signals to the Capstan Servo PWA, and logic signals to the Tape Timer PWA.

1-50. Capstan Servo PWA. The Capstan Servo PWA occupies position 15 of the electronics assembly. The major function of this PWA is to control the speed and phase of the capstan motor in all modes of operation. It operates with the Control Track and MDA PWA's to fulfill this function, and contains three of the four signal generation circuits required to drive the capstan motor. These are the tach position servo, the velocity servo, and slow motion pulse drive circuitry. The fourth circuit,

the control track servo, is located on the Control Track PWA.

1-51. AST Driver PWA. The AST Driver PWA is supplied only as part of the AST option, and is mounted at the rear of the VPR to the left of the power chassis assembly. This PWA amplifies low level drive signals from the AST servo to the high voltages required to drive the AST head. A safety switching circuit is incorporated to remove this high voltage when the scanner is not turning.

1-52. Control

The control section contains four PWA's which regulate all functional modes of the VPR-2B.

1-53. Control PWA. The Control PWA occupies position 17 of the electronics assembly. This PWA provides processing of operator commands, and performs many housekeeping chores within the VPR. Examples include: processing of play, slow motion, and still mode logic commands, latch reset commands during power on transitions, and solenoid drive signals for capstan, supply reel, and takeup reel solenoids. Also present is circuitry to control audio muting and spot erase functions.

1-54. Search PWA. The Search PWA occupies position 18 of the electronics assembly. This PWA provides two major functions: control of the transport while in search mode, and control of the transport in rewind or fast forward modes. Search operation is affected through the use of an up/down frame counter that increments the count for forward movement, and decrements the count for reverse movement. Reel drive control during fast wind is affected through the use of rewind and forward shuttle logic.

1-55. Tape Timer PWA. The Tape Timer PWA occupies position 19 of the electronics assembly. This PWA provides an electronic representation of tape movement with respect to direction and position. It receives pulses from the tape-driven tachometer portion of the timer idler assembly, then processes this information, directing the output to a time readout assembly. The PWA also supplies direction and speed information to the control system.

1-56. Readout PWA. The Readout PWA is mounted behind the control panel, with display devices and switches attached to it. This PWA performs two functions. First, as the timer readout, it displays numerical information in hours, minutes, seconds, and frames. Second, it provides local/remote switch isolation for some VPR functions. A display multiplexer is provided to sequence data to the digits. When the VPR is equipped with a time-code reader/generator the Readout PWA will display the time code or time code user bit information.

1-57. Transport

The transport contains mechanical and electronic assemblies which control tape movement. These assemblies include mechanical drive components are powered by the motor drive amplifier (MDA) assembly, which is mounted on the rear upper left portion of the transport. The MDA assembly provides drive voltages to the capstan, scanner, supply, and takeup motors. To perform these functions, it receives both analog and digital information from numerous control and servo circuits. In addition to the drive signals, this assembly provides other shuttle control functions for the supply and takeup motors.

1-58. Connector Panel Assembly

The connector panel, part of the electronics assembly, contains all VPR input and output connectors except ac line and console power.

1-59. POWER REQUIREMENTS

1-60. Line Voltage Select Jumpers

The VPR-2B has a captive power cord with a three-prong connector. To select the appropriate windings on the power supply transformer primary, jumper plugs (one 4-pin, one 3-pin) must be inserted into the LINE VOLTAGE SELECT connector (Figure 1-4) in the correct locations. The input power requirements for both domestic and overseas use are listed in Table 1-2. The correct location for both jumper plugs is indicated on a data plate shown in Figure 1-4. In Figure 1-4, the rear cover has been removed from the transport to provide a better view of the LINE VOLTAGE

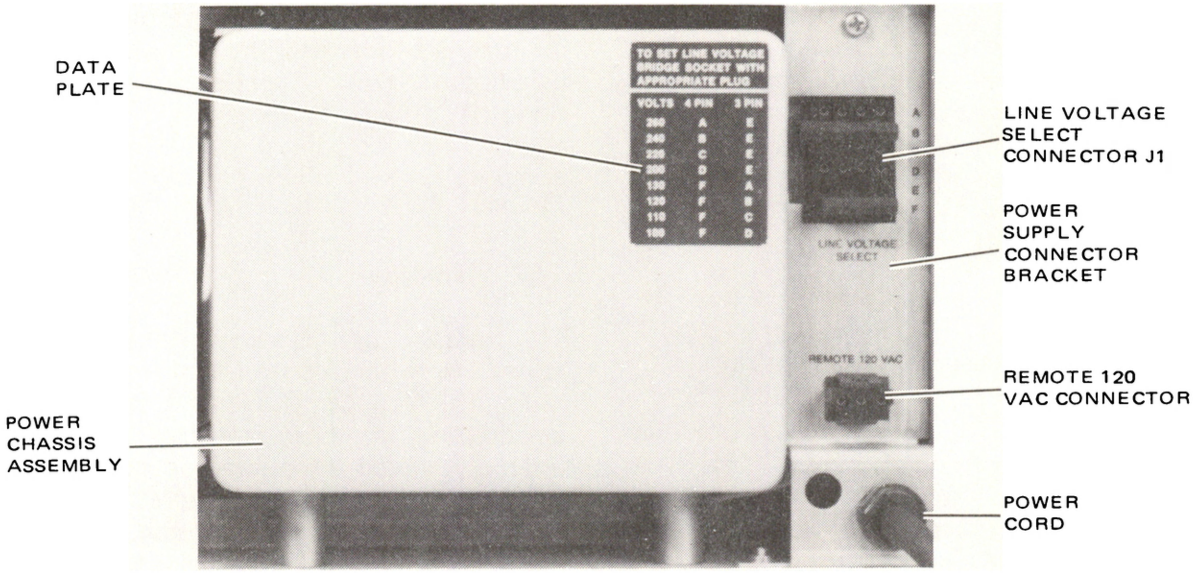


Figure 1-4. AC Power Selection

Table 1-2. VPR-2B Power Requirements

POWER INPUT	REMARKS
Prime Power Frequency	50 to 60 Hz, single phase
Input Voltages	100/110/120/130 Vac, ± 10% 200/220/240/260 Vac, ± 10%
Input Current:	
Tabletop	115 Vac, nominal 5.5A 230 Vac, nominal 2.8A
Studio Console with TBC and Color Monitor Bridge	115 Vac, nominal 10.5A; 230 Vac, nominal 5.5A

SELECT connector. However, removal of this cover is not necessary when checking or changing jumper plug locations, as an access plate (with a data plate attached) is fastened to the extreme right portion of the rear cover.

1-61. Remote 120 Vac Connector

The remote 120 Vac connector is located on the power supply connector bracket just below the LINE VOLTAGE SELECT connector (Figure 1-4). This connector can be utilized to control (via the VPR control panel POWER switch) the application or removal of 120 Vac line voltage for VPR console and monitor bridge equipment.

1-62. SIGNAL REQUIREMENTS

There are no unusual requirements with respect to VPR signal requirements. The system is designed to be compatible with common video production equipment already in service.

1-63. Signal Inputs

Video inputs should be a nominal one-volt peak-to-peak in amplitude (0.5 to 2.0 volts). Comp video amplitude should be from 0.5 to 2.0 volts in amplitude (peak-to-peak). Audio input amplitude should not exceed the range of from minus 24 dBm to plus 24 dBm. Audio line input impedance is 50K ohms balanced (50 Hz to 15 kHz).

1-64. CONFIGURATIONS

VPR-2B is available in different configurations to suit customer requirements. Broad configuration categories are described below. Refer to the sales order, and to Ampex marketing for specific information.

1-65. Basic Configurations

Certain functions, basic to VPR-2B operation, differ in compliance with the machine's destination market.

1-66. Television Standards. VPR-2B is configured to operate with the television standard with which it will be used. Basic choices are: NTSC, 525-line system; PAL, 625-line system; PAL-M, 525-line; SECAM, and 625-line. Other choices exist, and may be discussed with Ampex marketing.

1-67. Color Framer. The color framer PWA has versions to conform with television standards described above.

1-68. Options and Accessories

Several VPR-2B options are available to enhance system capabilities. These options are described in this section under paragraph 1-5, *Capabilities with VPR-2B Options.* Accessories for VPR-2B include such items as: various consoles, video monitor, waveform monitor, audio monitor, etc. Contact Ampex marketing for specific information.

1-69. INTERFACE CONSIDERATIONS

1-70. Time Base Corrector Interface

The AMPEX TBC-2B is the ideal time base corrector to use with VPR-2B. Figures 1-5 and 1-6 illustrate VPR-2B-to-TBC-2B interconnections for 525 and 625, respectively. The interconnect cable (34-conductor Brundy) carriers signals relating to transport variable speed, still frame, and AST functions.

1-71. Console Interconnections

Figure 1-7 provides interface details pertaining to VPR-2B installation in a console. This interface drawing pertains to a console equipped with the picture monitor, vectorscope, waveform monitor, and related hardware (specific monitor types/models determined by customer order). Figure 1-7 is provided for information purposes only.

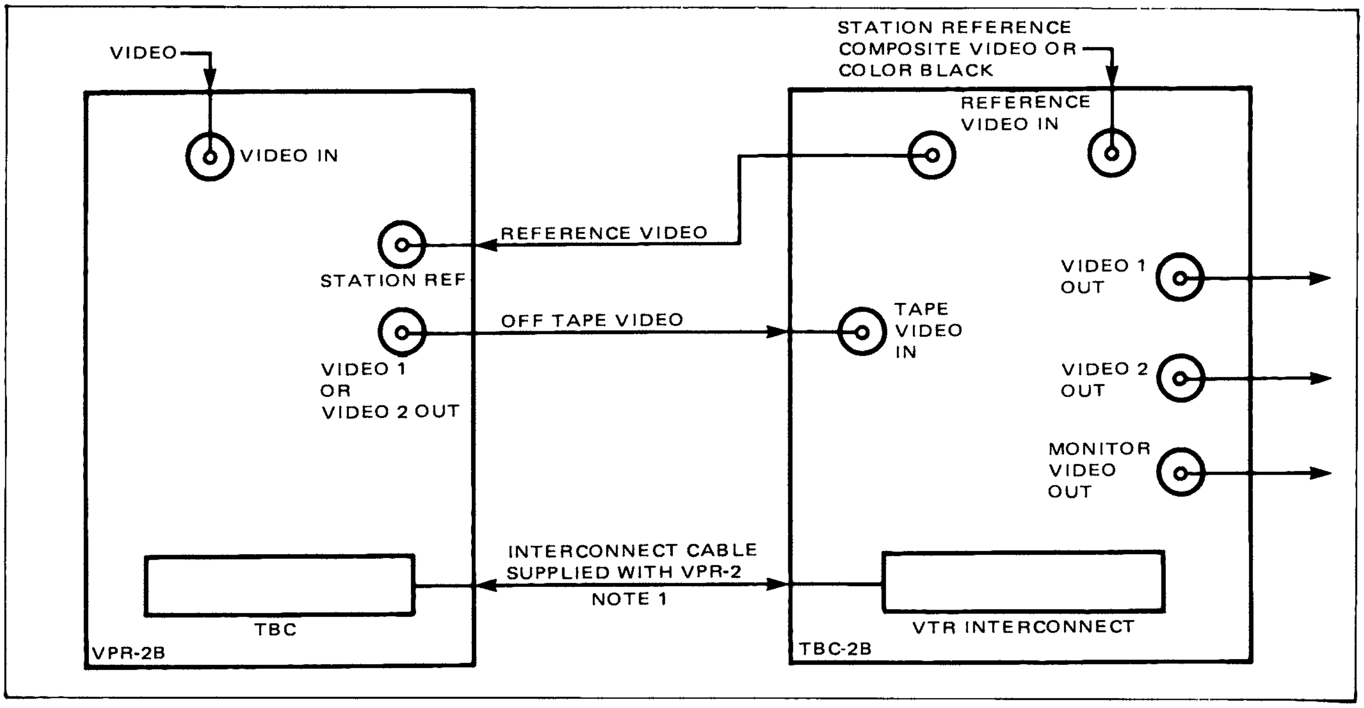


Figure 1-5. VPR-2B-to-TBC-2B Interface (525 System)

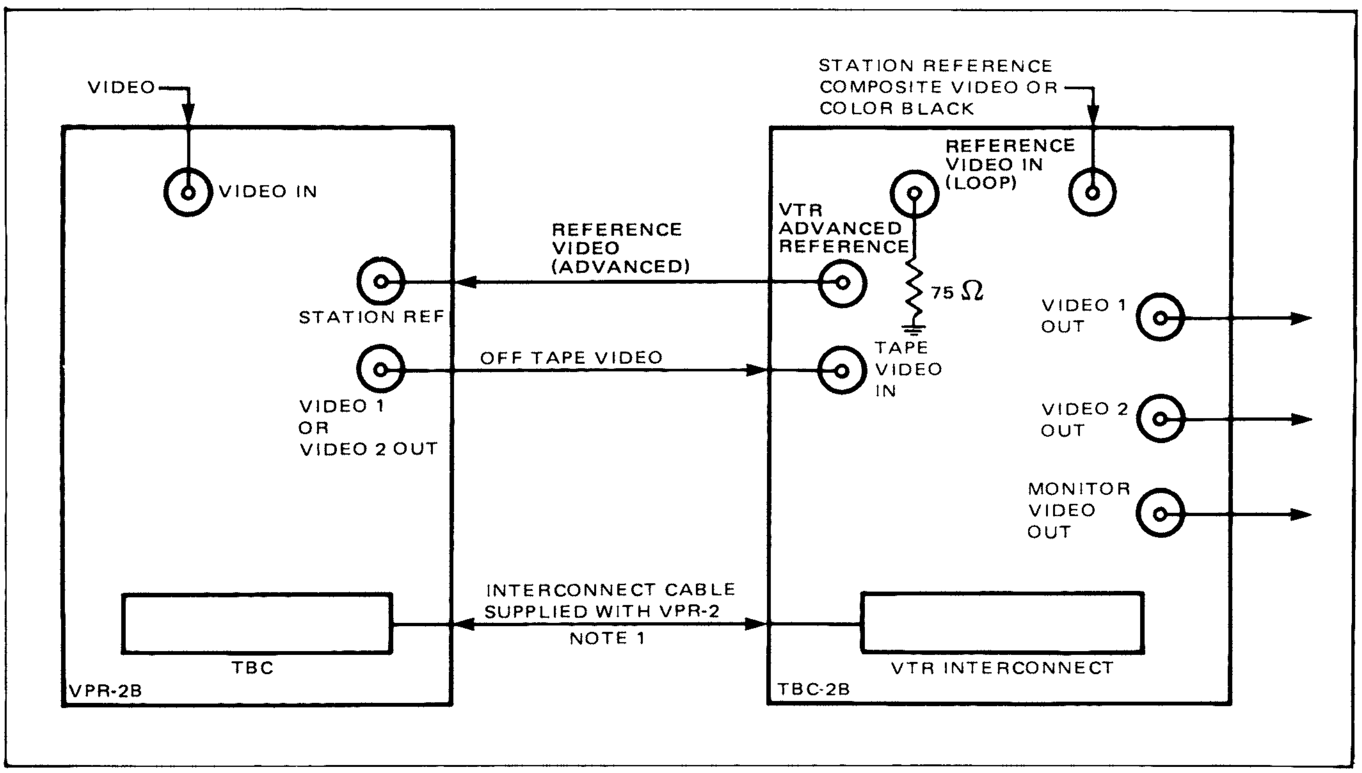
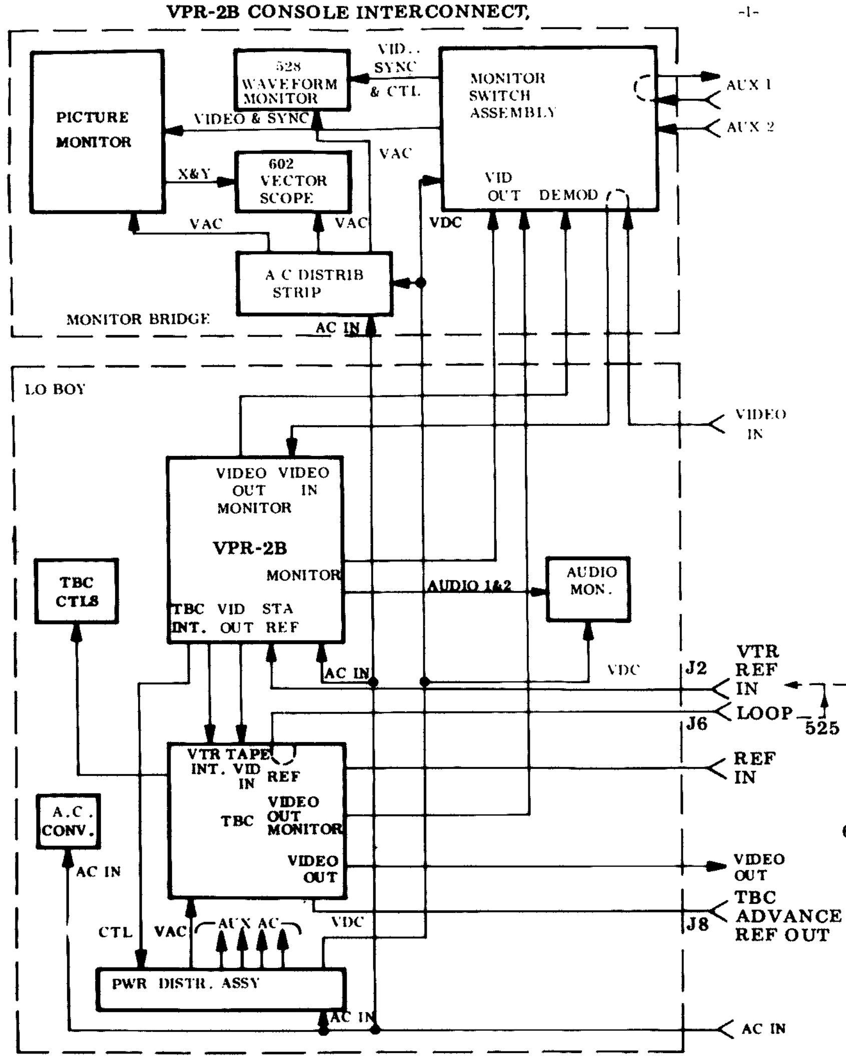
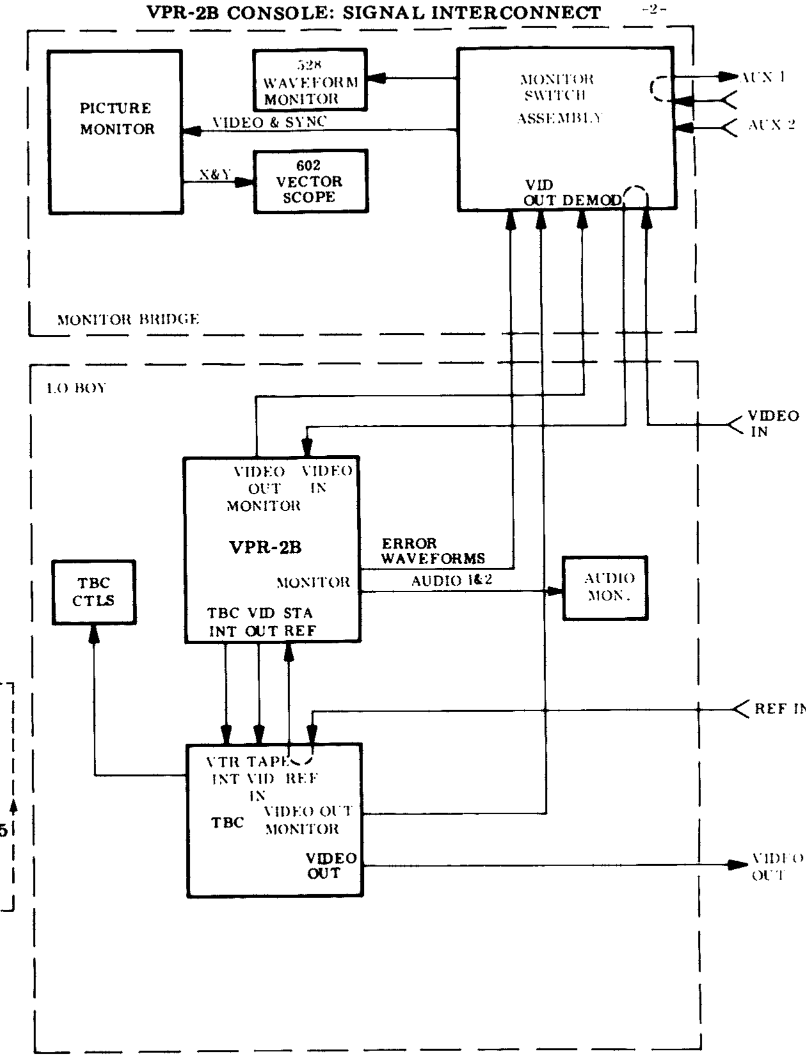


Figure 1-6. VPR-2B-to-TBC-2B Interface (625 System)

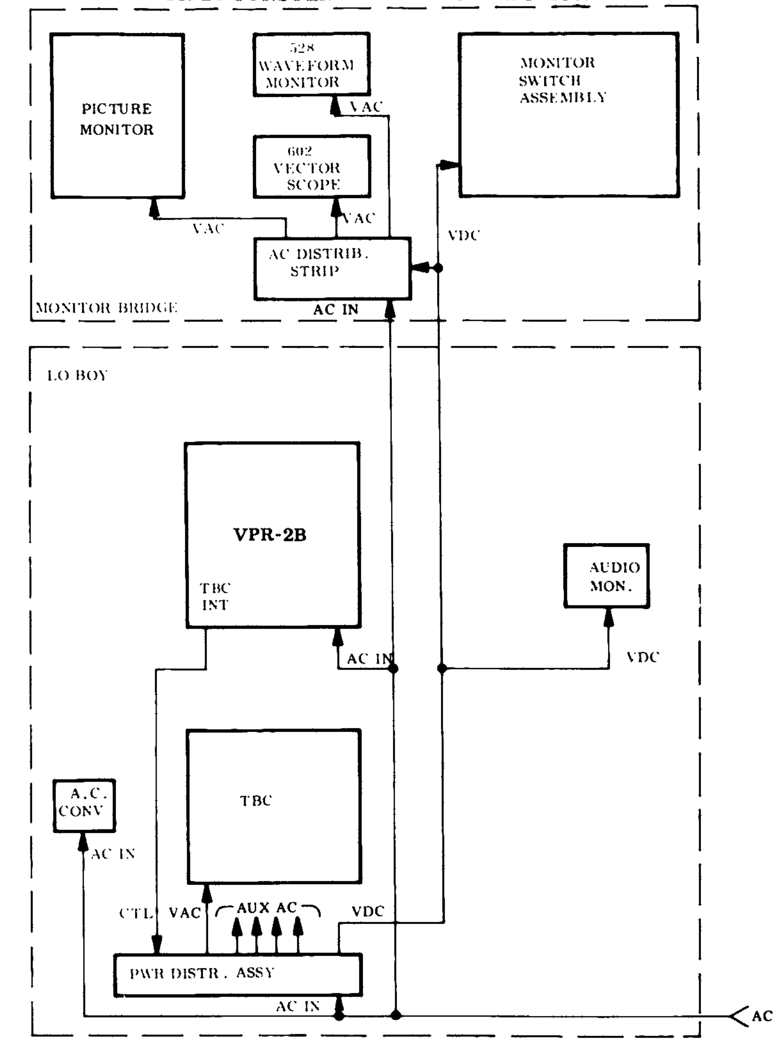
VPR-2B CONSOLE INTERCONNECT, -1-



VPR-2B CONSOLE: SIGNAL INTERCONNECT -2-



VPR-2B CONSOLE: POWER DISTRIBUTION



ERROR WAVEFORMS

RF ENV	RF ENVELOPE FROM EQUALIZER. PWA 4
DROP-OUT	RF DROPOUT FROM P/B SYNC. PWA 8
CTL TRACK	CONTROL TRACK FROM CONTROL TRACK. PWA 14
DRUM ERROR	DRUM ERROR SIGNAL FROM SCANNER SERVO, PWA 11
AST ERROR	AST ERROR SIGNAL FROM AST SERVO PWA 9
	SPARE-AVAILABLE AT LO J6-EE/KK
VIDEO	VIDEO WAVEFORM SELECT

VIDEO WAVEFORMS

VIDEO IN	VIDEO INPUT TO CONSOLE (LOOP-THRU)
DEMOD OUT	VIDEO OUT FROM VPR-2B
VIDEO OUT	VIDEO OUT FROM TBC
CHAR GEN	INPUT (LOOP THRU) ON BACK OF BRIDGE
AUX 2	INPUT (75 Ω TERM.) ON BACK OF BRIDGE
EXT SYNC	UNLIGHTED (OUT)-PIX MON SYNC IS STRIPPED FROM SIGNAL LIGHTED (IN)-PIX MON SYNC IS VTR SWITCHED REF.

PICTURE MONITOR	SIGNAL-VIDEO SIGNALS AS SELECTED ABOVE SYNC -COMP SYNC. STRIPPED FROM SELECTED SOURCE OR VTR SWITCHED REFERENCE (EXT SYNC SW)
VECTOR SCOPE (EXISTS ONLY IF USING TEK COLOR MONITOR)	X/Y SIGNALS FED FROM PICTURE MONITOR
WAVEFORM MONITOR	SIGNAL - ERROR WAVEFORMS AS SELECTED ABOVE. IF VIDEO IS SELECTED, W.F. MON FOLLOWS THE PICTURE MONITOR (LOWER BUTTONS) SYNC- IF ERROR: REMOTELY PROGRAMMED TO ACCEPT EXTERNAL FEED-VTR REF FRAME IF VIDEO: INTERNALLY SYNCHRONIZED BY SOURCE.

Figure 1-7.
VPR-2B Console Interconnections

THEORY OF OPERATION

2-1. INTRODUCTION

This section describes functional operation of the VPR-2B Video Production Recorder, and is therefore written on a block diagram level. Schematic diagrams of circuits described herein can be found in the VPR-2B Parts Lists and Schematics Manual, Catalog No. 1809384. Reading Section 1 of this manual, General System Information, facilitates understanding the system theory which follows. A cursory explanation of the Type C format for which the VPR-2B is designed is also included.

2-2. TYPE C FORMAT

The SMPTE Type C format for one-inch helical videotape recording exists to ensure that there is compatibliity (interchange) among tapes recorded by, and played upon different videotape recorders, including those of different manufacturers. The Type C format is a non-segmented format in which one rotation of the scanner (or head drum) records one field of television video.

This section contains general information about the SMPTE and EBU Type C formats. For specific format details (dimensions, parameters, etc.) refer to SMPTE publications C98.18, C98.19, C98.20, RP85, and RP 86, or to EBU Format C technical information, sheet 7.

The SMPTE and EBU Type C format provides specifications covering such operational considerations as:

1. Placement and orientation of record tracks on tape.
2. Scanner, transport, and guiding geometry required to produce the record tracks.
3. Electronics specifications, including parameters for audio, video, control track, and sync track signals.

2-3. Record Tracks

Figure 2-1 shows a section of tape viewed from the oxide side. By making the record tracks visible, this drawing shows track locations for the helical (angled) and the longitudinal tracks. The longitudinal tracks (those parallel with edge of tape) are recorded by heads of the stationary audio head stack. Helical video and sync tracks are recorded by heads of the rotating scanner, upper portion of scanner assembly. The record track layout is the same between NTSC and PAL Type C Format versions. However, the angle and length of the helical tracks, and certain other record track dimensions differ somewhat due to different tape speed and different scanner rotation speed.

2-4. Format Options

Figure 2-1 shows three format options affecting record tracks near the tape's bottom edge. The basic option (left-hand portion of figure) has no sync track. With this option, information occurring during vertical interval drop-out time is lost, and cannot be recorded nor played back. With the sync track option (center of figure), information occurring during vertical interval drop-out time is recorded/played back by sync track heads.

The third option (right portion of figure) allows PAL/SECAM machines equipped for EBU audio 4 to record the fourth audio track in the area of tape normally reserved for sync track.

2-5. Control Track. Different television recording formats use different schemes for recording control track. The SMPTE C format records a

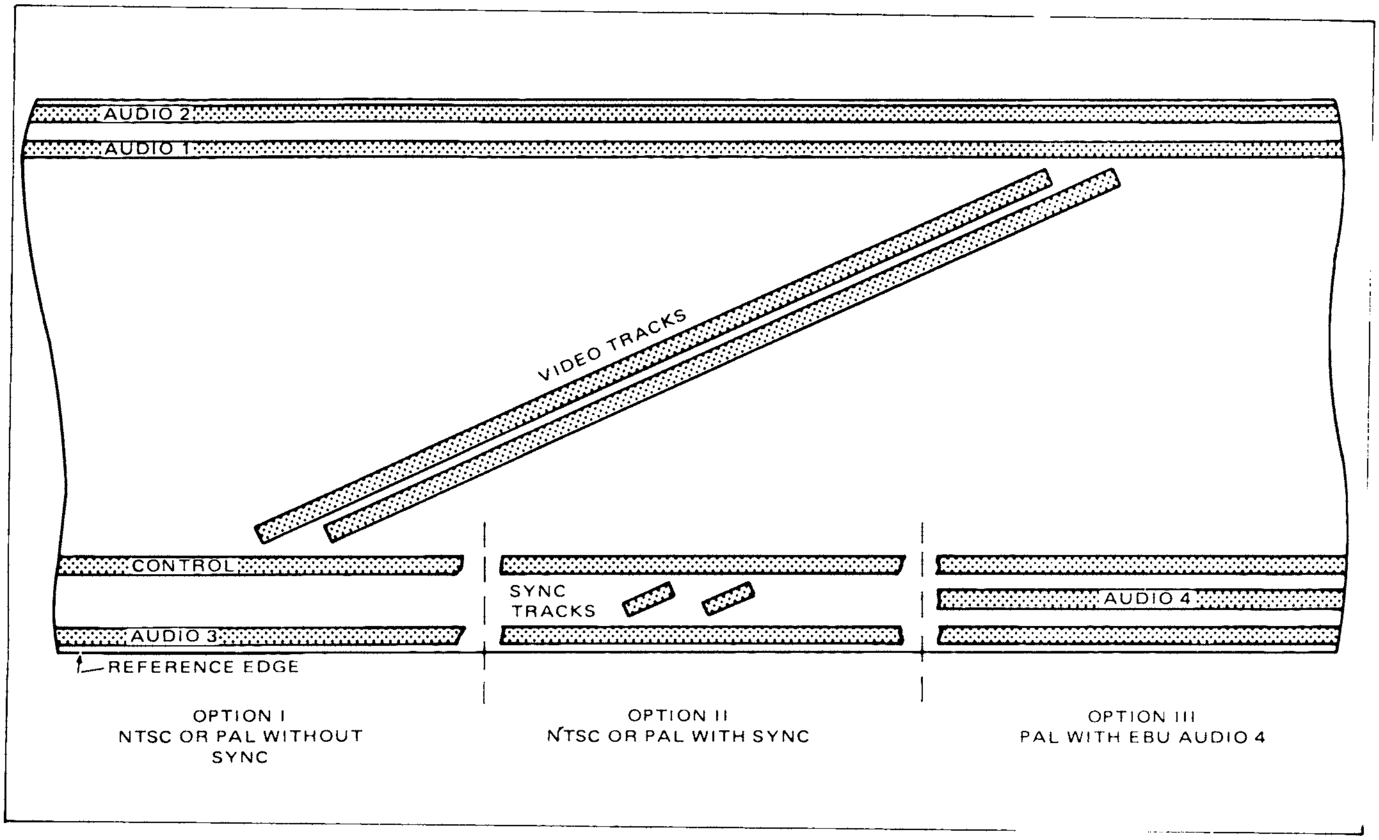


Figure 2-1. Type C Format Options

saturated control track which has a square wave fundamental. The EBU C format uses a biased pulse signal. This latter method uses less energy, and eliminates the low frequencies associated with a saturated signal. This results in less crosstalk into adjacent channels, and makes the addition of a high quality audio 4 track (in place of sync track) practical.

2-6. Audio 3. The audio 3 track, standard with the Type C Format, is normally used for time code or cueing purposes. However, since the track width is the same as that of audio 1 and audio 2, the audio 3 track has the capability of being a high quality audio track.

2-7. Scanner. Figure 2-2 provides two views of the scanner portion of the scanner assembly (called upper drum by Type C format test). The scanner rotates in a clockwise direction, while the tape travels around the scanner in a counterclockwise direction (as viewed from the front of machine). The tape elevates as it travels around the scanner (by guides, not shown). This action accounts for the helical tracks laid down by scanner heads which pass across the tape at an angle.

The top view of Figure 2-2 shows the position of all six scanner head positions. Three are for video, and three are for the optional sync track. A machine lacking the sync track function will have non-functional "dummy" heads installed in place of the sync track heads. The presence of these dummy heads preserves the head-to-tape geometry required for Type-C operation.

2-8. Vertical Interval Dropout. Because the tape wrap around the scanner is less than 360 degrees, there is a period of scanner rotation in which the video head does not contact the tape, as shown in Figure 2-3. This is the vertical interval dropout period. Information which would otherwise be lost during this period, may be recorded/ played back by optional sync heads.

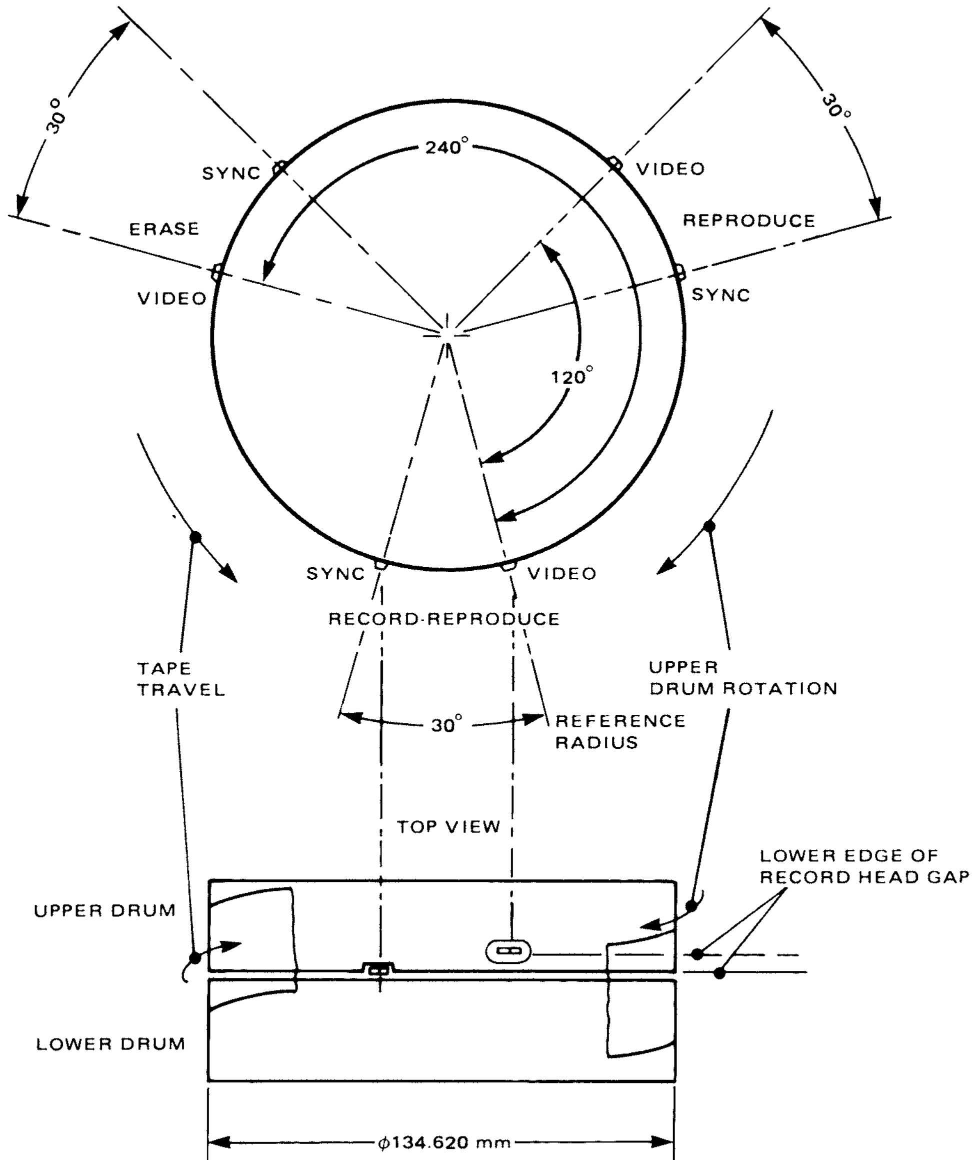


Figure 2-2. Scanner

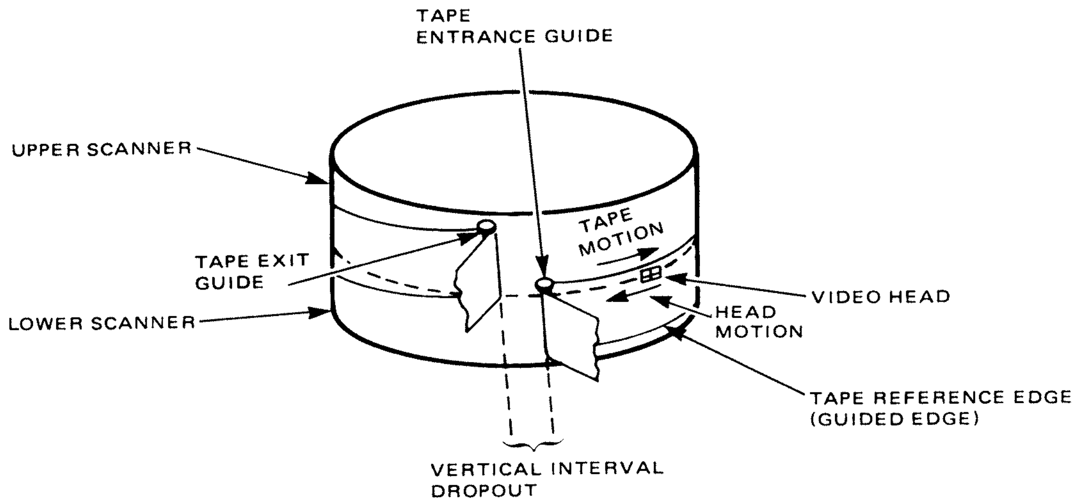


Figure 2-3. Vertical Interval Dropout

2-9. GENERAL

The theory of operation which follows covers NTSC, PAL-M, and PAL/SECAM version machines. While most of the descriptive text and figures apply to all systems, that which is unique to a given system is identified as such in paragraph headings and figure titles.

2-10. Overall System Operation

Figure 2-4 is an overall system block diagram for VPR-2B. Each block represents a functional subsystem, whether electrical or mechanical, of the VPR-2B. A subsystem may be comprised of multiple printed wiring assemblies (PWA's). The following theory description is organized according to the functional blocks shown in Figure 2-4. The heads block description is included with the associated audio/video subsystem description.

2-11. Control. The control subsystem contains four PWA's which regulate all functional modes for VPR-2B. Machine operation begins with operator initiated commands entered at the control panel or remote control panel. The Control PWA interfaces the control panel to process operator commands (play, slow motion, etc.) and to perform many housekeeping chores. The Search PWA controls the VTR in the search, rewind, and fast forward modes.

The Tape Timer PWA tracks tape movement – using the Tape Timer Tach to do so. This PWA drives the time readout assembly and gives speed/direction information to the control system except when the Time Code Reader Generator PWA is installed. The Readout PWA mounts display devices showing tape running time, and switches pertaining to local/remote operation.

2-12. Transport. The transport contains mechanical and electronic assemblies which control tape movement (reel motors, capstan motor, scanner motor, etc.). The transport is controlled by the control and servo subsystems and, indirectly, by operator controls.

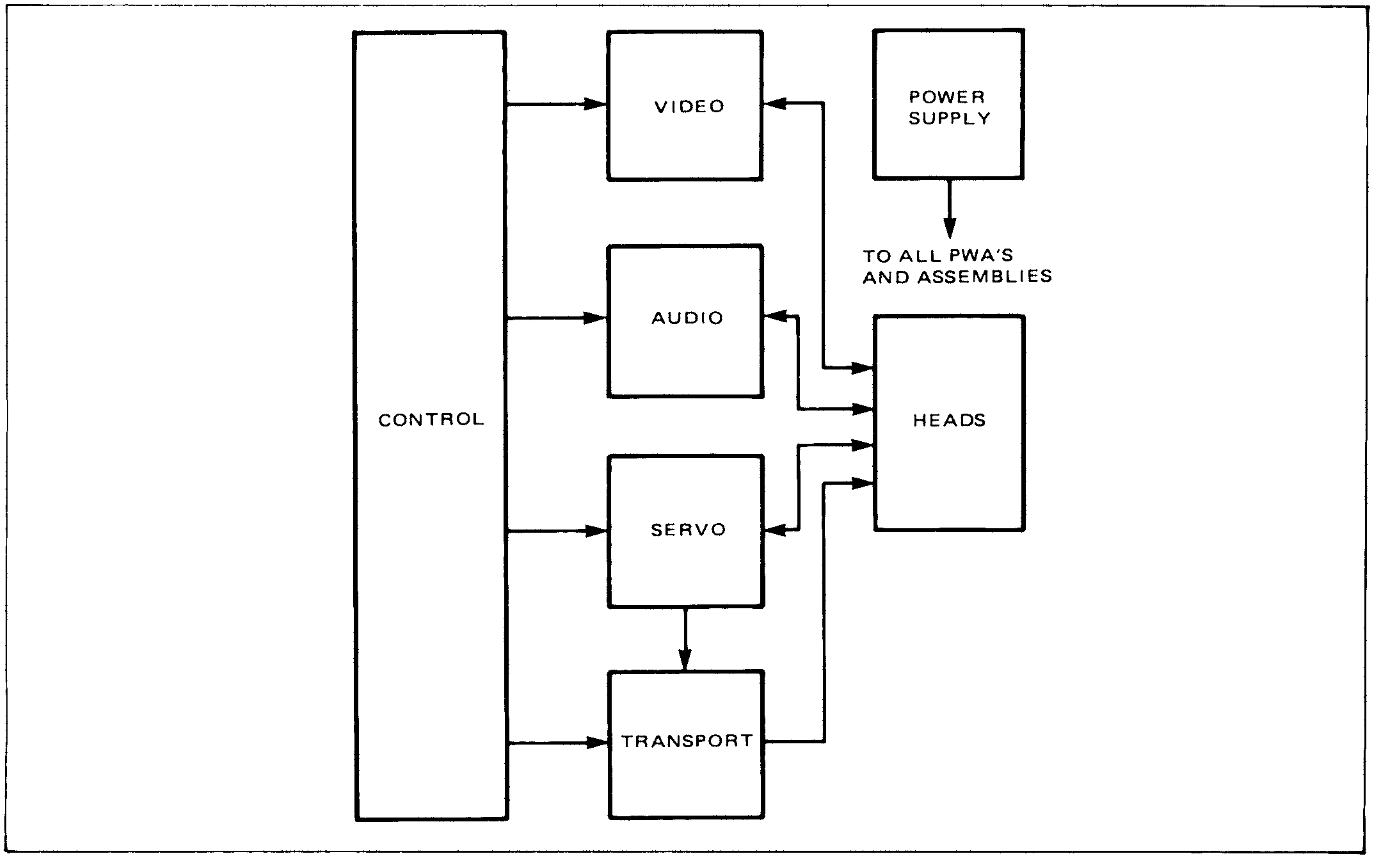


Figure 2-4. Overall System Block Diagram

2-13. Servo. The servo subsystem is comprised of nine PWA's. These PWA's provide regulation over tape travel, scanner head rotation, tape tension, and, in the AST option, transverse head position.

2-14. Video. The video sybsystem contains seven PWA's which provide interface and processing for the video signals. In record mode, a composite video signal from camera or other source is modulated onto an rf signal to drive the record head. In play, the reverse occurs, where rf from the play head is processed into appropriate video for studio use (via time base corrector) and monitor operation.

2-15. Audio. The audio sybsystem contains a maximum of seven PWA's which provide interface and processing for all audio and cue signals. This includes bias and erase signals for audio and video heads, and vu or ppm meter drive signals.

2-16. Power Supply. The power supply is made up of a power chassis assembly and a power regulator assembly. The power supply converts house 110 Vac or 220 Vac to all regulated and unregulated voltages required for VPR operation. This includes providing power to the AST Driver PWA for AST head deflection.

2-17. Control System Circuit Description

2-18. General. VPR operation is controlled by the control panel working with the Control, Search, Tape Timer, and Readout PWAs (see Figure 2-5, Control System Block Diagram). The operator selects operating modes (play, slow motion, etc.) at the control panel. The control circuitry allows one mode only to prevail at any given time, and produces the necessary control signals to control other system PWA's during operation.

2-19. Control PWA No. 17. The Control PWA processes operator commands, both local and remote, and performs many housekeeping chores within the VTR. Examples include: processing of play, slow motion, and still frame commands; generating latch reset commands during power-on transitions, and providing solenoid drive signals for the capstan, supply reel brake, and takeup reel brake solenoids. Refer to Figures 2-6 through 2-13, and to schematic diagram no. 1400178, while reading the description below.

2-20. *Primary Control.* Figure 2-6 illustrates the basic wiring configuration for the control panel switches. Virtually all switch commands are formed through bus driver amplifiers located on the Time Readout PWA. Control signal destinations are denoted at the figure's righthand edge.

2-21. Shuttle Mode Latch. Upon pressing the VPR front panel shuttle (SHTL) button, the SHUTTLE SW signal is activated to the Control PWA. The signal passes through an RC noise filter and level converter circuit (Figure 2-7). The noise filter/level converter output is applied to the mode change command generator and to the mode latch. At this time, the previous mode (whether play, slow, etc.) is being held active by the mode latch via the respective mode driver to its input pin (as explained below). Thus the mode change command generator, a parity detector, experiences an even number of two inputs true. It responds by activating its even parity logic level output. The even parity output signal (1) clears the mode latch immediately of all modes, and (2) clocks the mode latch via the mode change one-shot after delay, causing it to latch the shuttle mode. The mode latch in turn forces the SHUTTLE SW input signal true via the shuttle mode driver, sustaining shuttle mode and keeping the SHTL button lamp lit.

The shuttle signal from the level converter is supplied to the shuttle latch, relieving its reset input. The REF VERT signal from the Reference PWA clocks the shuttle pot switch latch, and its toggling output clocks the shuttle latch, causing it to output WIND signal to the Search PWA. There, the WIND signal allows the direction logic and the shuttle logic to output forward and reverse drive signals to the appropriate reel MDA, driving the reel motor.

The shuttle mode signal, present at the mode latch output, is applied to the mode encoder PROM (programmable-read-only-memory). The program in this PROM is such that it activates the appropriate control logic for shuttle mode, as well as any mode that is currently in force, as well as providing inputs to the mode control PROM. Like the mode encoder PROM, the mode control PROM activates the appropriate control logic, based upon these inputs, in consideration of command inputs from the control panel controls.

2-22. *Safety Sense Circuit.* In the event an abnormal operating condition arises, the Search PWA safety sense circuit is capable of activating the AUTO STOP signal to the Control PWA. When active, this signal first clears, then clocks the mode latch, clearing all modes and substituting the STOP mode.

2-23. Shuttle Mode Switches

The shuttle mode select switch (S4-1) and the shuttle detent switch (S4-2) work together and separately (see Figure 2-7) to allow variations on shuttle operation. With S4-1 and S4-2 open, the shuttle pot switch is isolated from the shuttle mode select one-shot, and from the shuttle detent switch latch. The shuttle pot may be rotated to select direction and speed, but shuttle mode is not activated until the front panel SHTL button is pressed. If the shuttle pot is in any position other than detent (mid) position when the SHTL button is pressed, the transport will assume the direction and speed indicated by that position.

With S4-1 closed and S4-2 open, the shuttle pot switch couples to the shuttle mode select one-shot. This is the auto-shuttle position. The shuttle pot switch is open to ground in the detent position, closed to ground in off-detent position. With the shuttle pot in the detent position, it may be rotated to select direction and speed. This activates shuttle mode without the need to press the SHTL button. If not in detent, it must be rotated through detent to activate shuttle mode. When departing detent position, the shuttle pot switch supplies a ground to the shuttle mode select one-shot firing it. The one-shot output drives the shuttle mode driver (via OR gate) to activate the SHUTTLE SW signal and light the SHTL button indicator. From

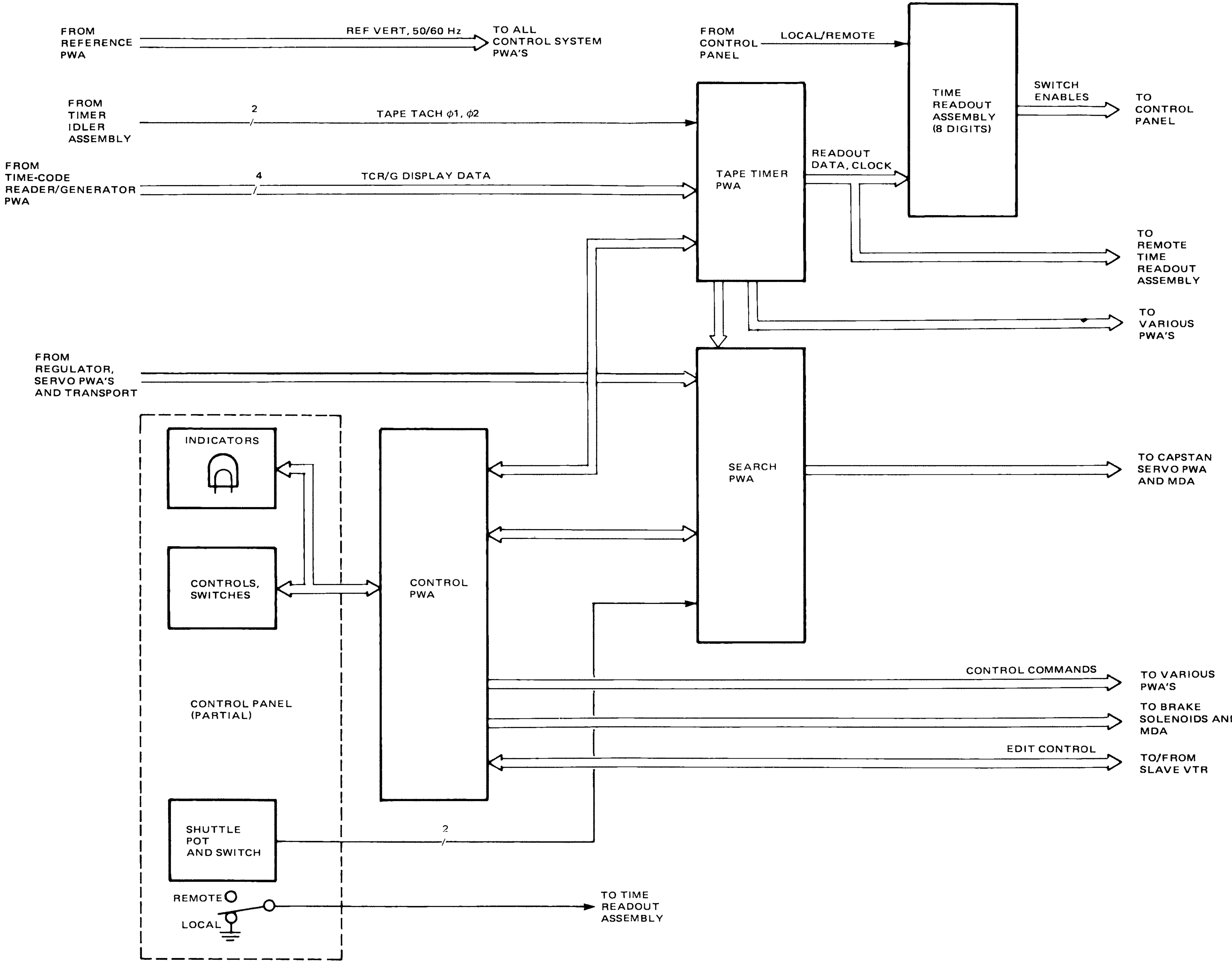


Figure 2-5. Control System Block Diagram

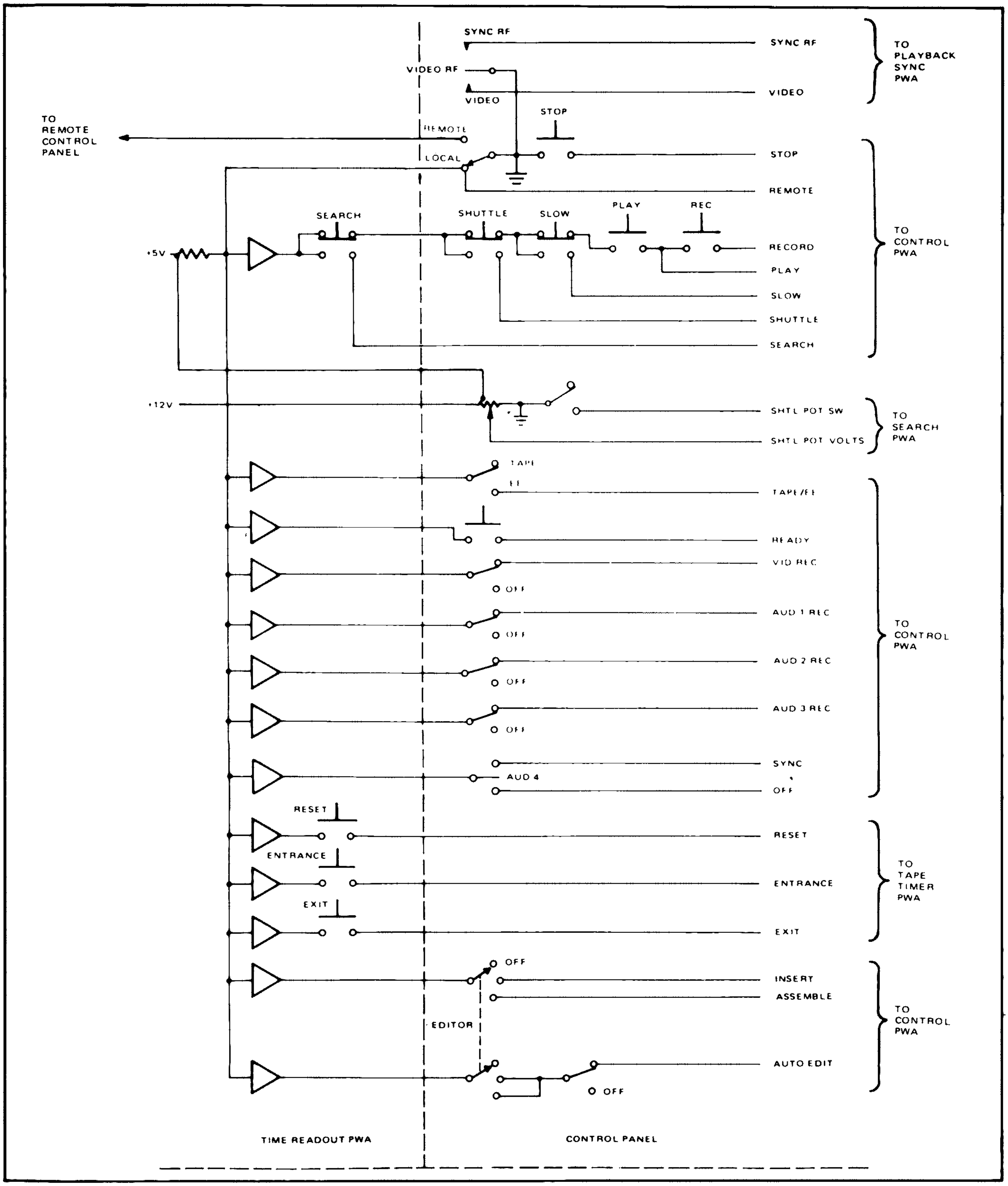


Figure 2-6. Primary Control

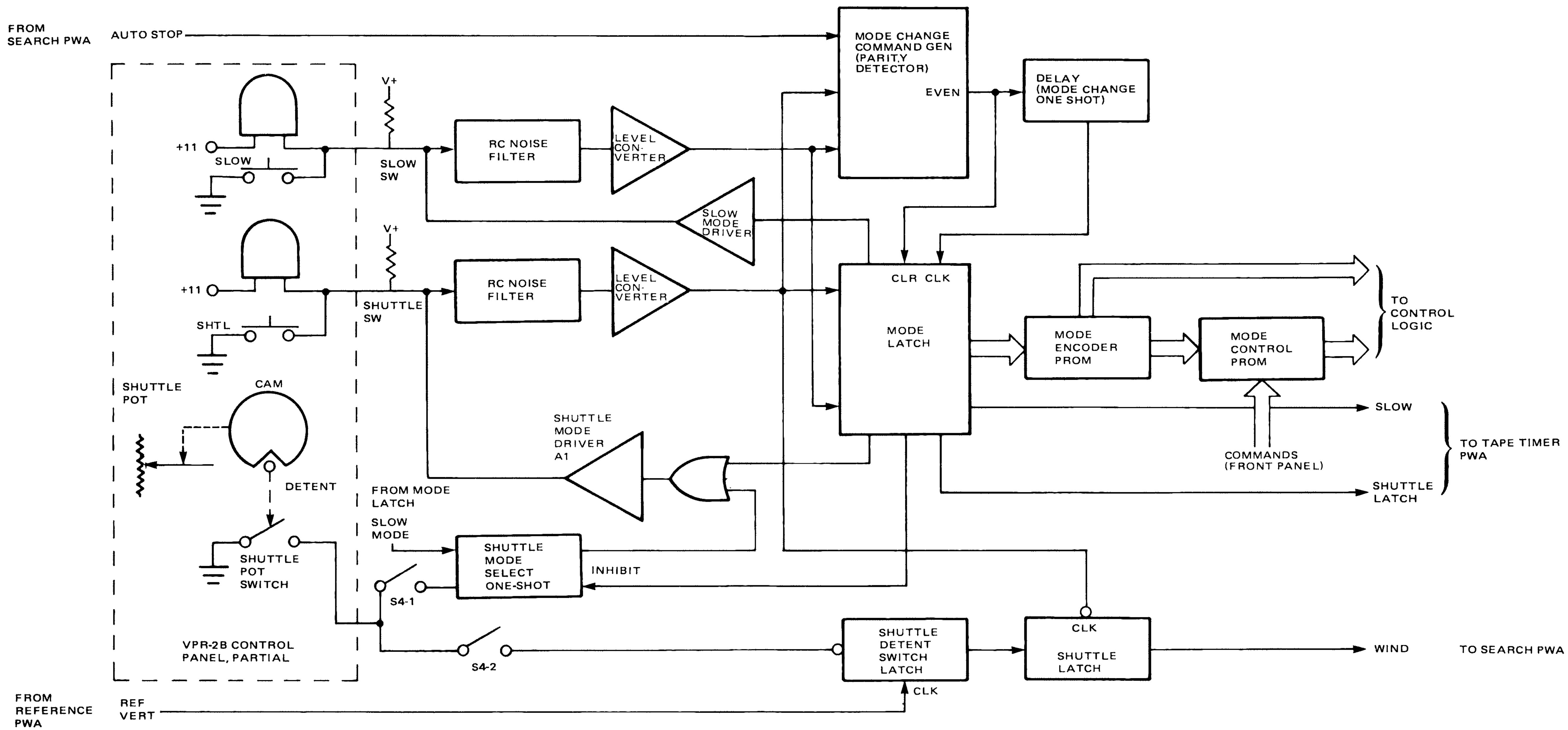


Figure 2-7. Control PWA
Shuttle Latch, Slow Motion Latch

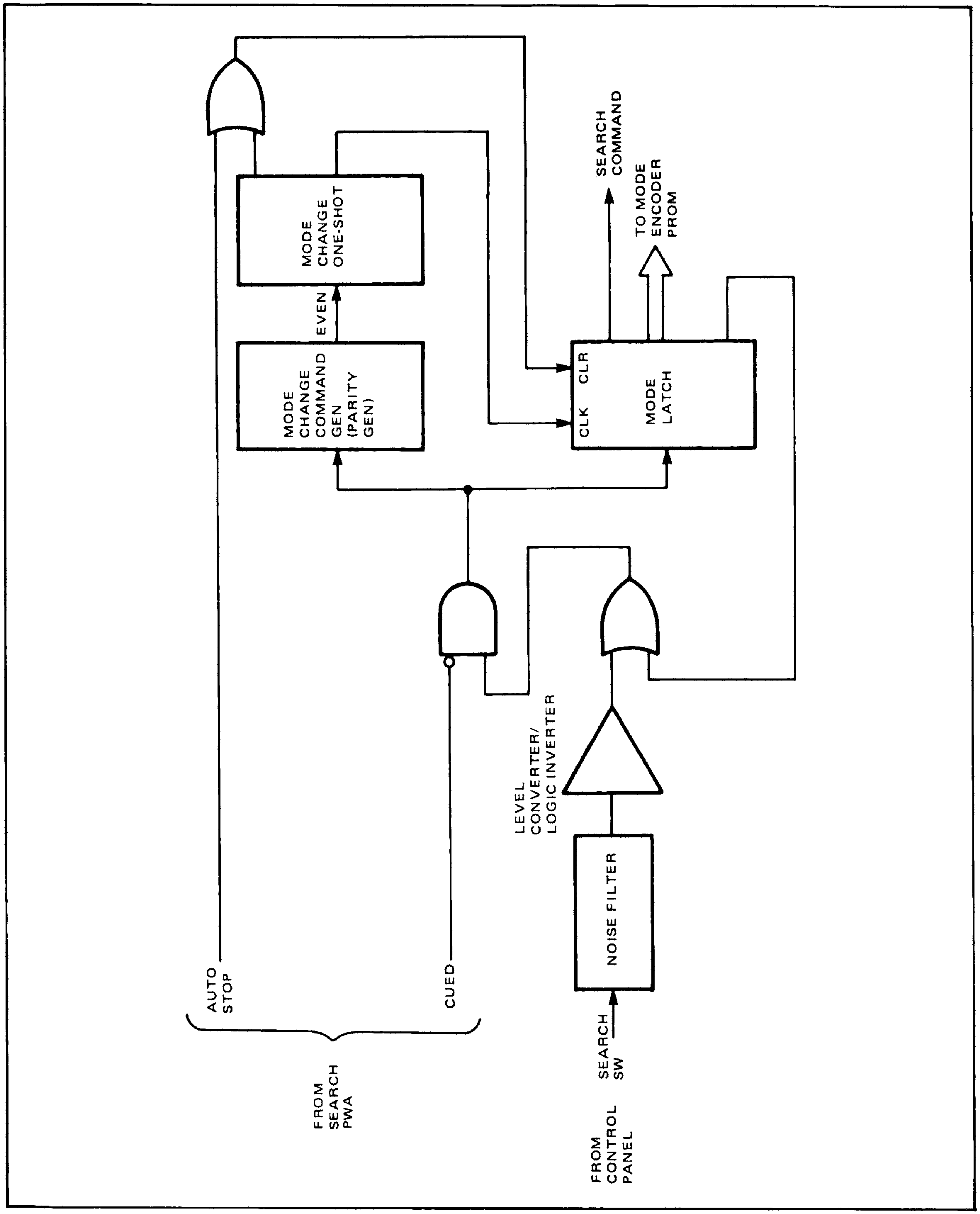


Figure 2-8. Control PWA Search Latch

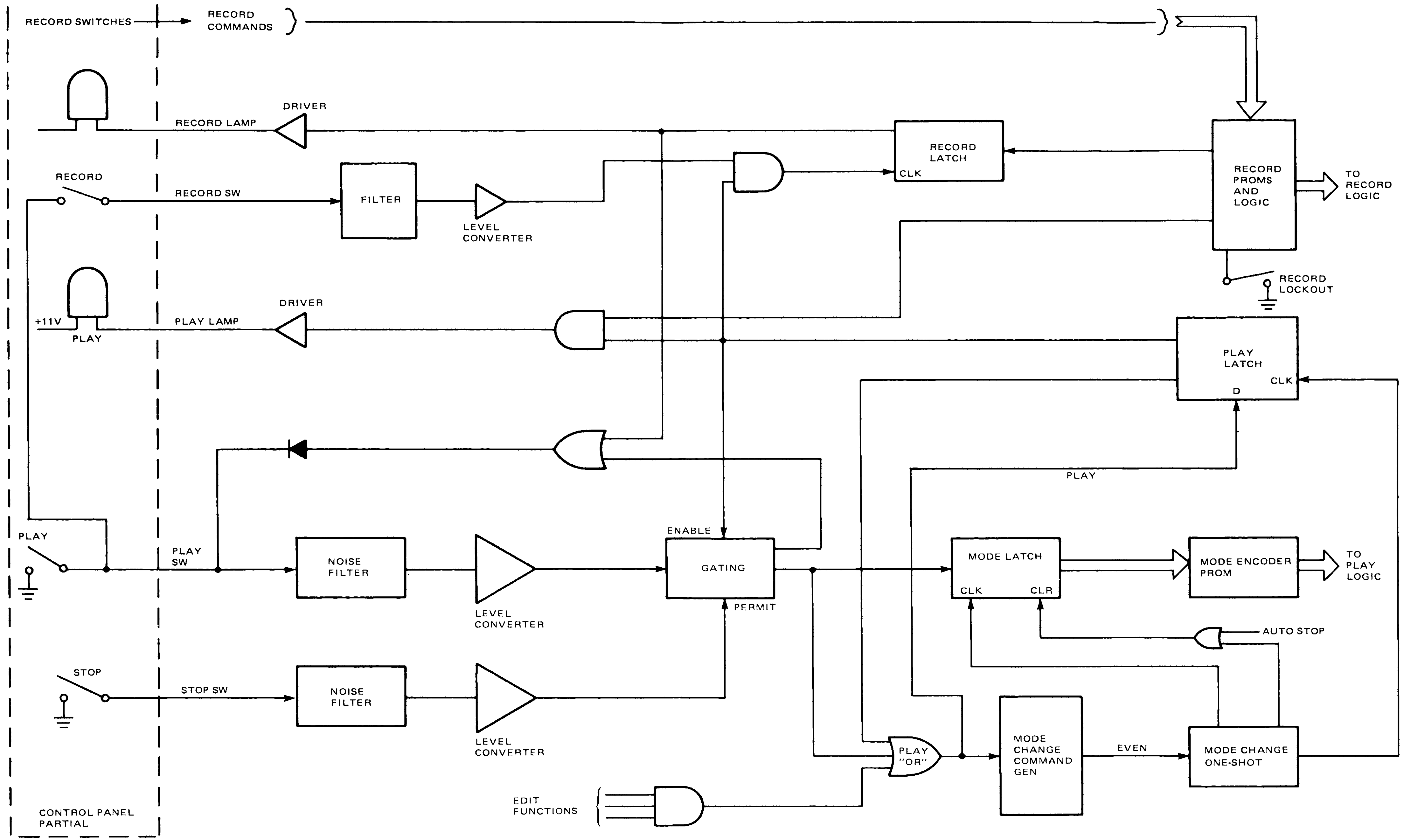


Figure 2-9. Control PWA
Play Latch, Record Latch

this point, shuttle mode is latched as with normal shuttle mode operation (described above). The shuttle latch inhibits the shuttle mode select one-shot from firing when in the slow, play, or record modes. Therefore, shuttle may not be entered using the shuttle pot from these modes. The SHTL button may be used to initiate shuttle mode as per normal operation.

With S4-2 closed and S4-1 open, shuttle mode is initiated by the SHTL button (only), and tape movement commences only when the shuttle pot is in, or passes through the detent position. This is so because the shuttle detent switch latch is held reset by ground from the shuttle pot switch, except when in detent position. With this latch reset, clock is withheld from the shuttle latch and no WIND signal is asserted to the Search PWA.

With S4-2 closed and S4-1 closed, shuttle mode is initiated by the SHTL button or by the shuttle pot, but tape movement commences only after the shuttle pot passes through the detent poition. In non-detent positions, WIND is withheld due to the detent switch latch being reset (as described above), but passing through detent fires the mode select one-shot (via S4-1), activating shuttle mode.

2-24. Slow Motion Latch. The slow motion latch operates in a similar manner to that of the shuttle latch. Pressing front panel SLOW button activates SLOW SW signal to the Control PWA (Figure 2-7).The signal if filtered, level converted, and applied to the mode change command generator, and to the mode latch. The mode change command generator's even parity output fires the mode change one-shot which clears and clocks the mode latch. The mode latch latches the slow mode by holding signal SLOW SW active (lighting the SLOW button indicator) via the slow mode driver.

2-25. Search Latch. Pressing the front panel SEARCH button produces the SEARCH SW signal sent to the Control PWA (Figure 2-8). The SEARCH SW signal is filtered and level converted in the same manner as the SHUTTLE SW and SLOW SW signals. The signal is then passed by an OR gate and an AND gate to the mode latch and the mode change command generator. The AND gate inhibits search signal passage once the VTR is cued, as indicated by an active CUED signal from the Search PWA. Upon detecting the search mode input along with the current mode input (even inputs), the mode change command generator (even output) clears and clocks the mode latch (via the mode change one-shot and an OR gate) just as was done with the shuttle mode latch. This action latches the search mode.

The mode latch asserts SEARCH signal to the Search PWA, and to the mode encoder PROM (not shown). The Search PWA uses the SEARCH signal to initiate the search operation, reversing transport motion to return to the cue point. The mode encoder PROM working with the mode control PROM produces the necessary logic signals to carry out search. Search PWA logic drives the front panel SEARCH LED indicator, blinking it during search, and lighting it steadily when cued.

2-26. Play Latch. The play latch is similar to the shuttle latch and search latch, with some exceptions. The front panel PLAY switch produces signal PLAY SW when pressed. At the Control PWA, PLAY SW is filtered and level converted (Figure 2-9). After this, the signal encounters gating which allows it to pass provided the STOP switch is not pressed. The gating output encounters the mode latch directly, and the mode change command generator via the three input play "OR" gate. The play OR gate output (1) applies "play" state to the play latch, and (2) causes the mode change command generator to assert its even output, clearing the mode latch and firing the mode change one-shot. Upon time out, the mode change one-shot output clocks both the mode latch and the play latch, both of which latch in the play mode.

The mode latch outputs drive the mode encoder PROM and (indirectly) the mode control encoder PROM to activate the necessary play mode signals. The play latch output does three things. It lights the Play button indicator provided the record PROM's indicate that record mode is not in progress. It enables the gating to latch the PLAY SW signal true, via the OR gate. Note that record circuits can also latch PLAY SW true (OR gate) for record purposes, latching both the record and play latches though the PLAY button will not light. And (lastly), it latches play mode via another

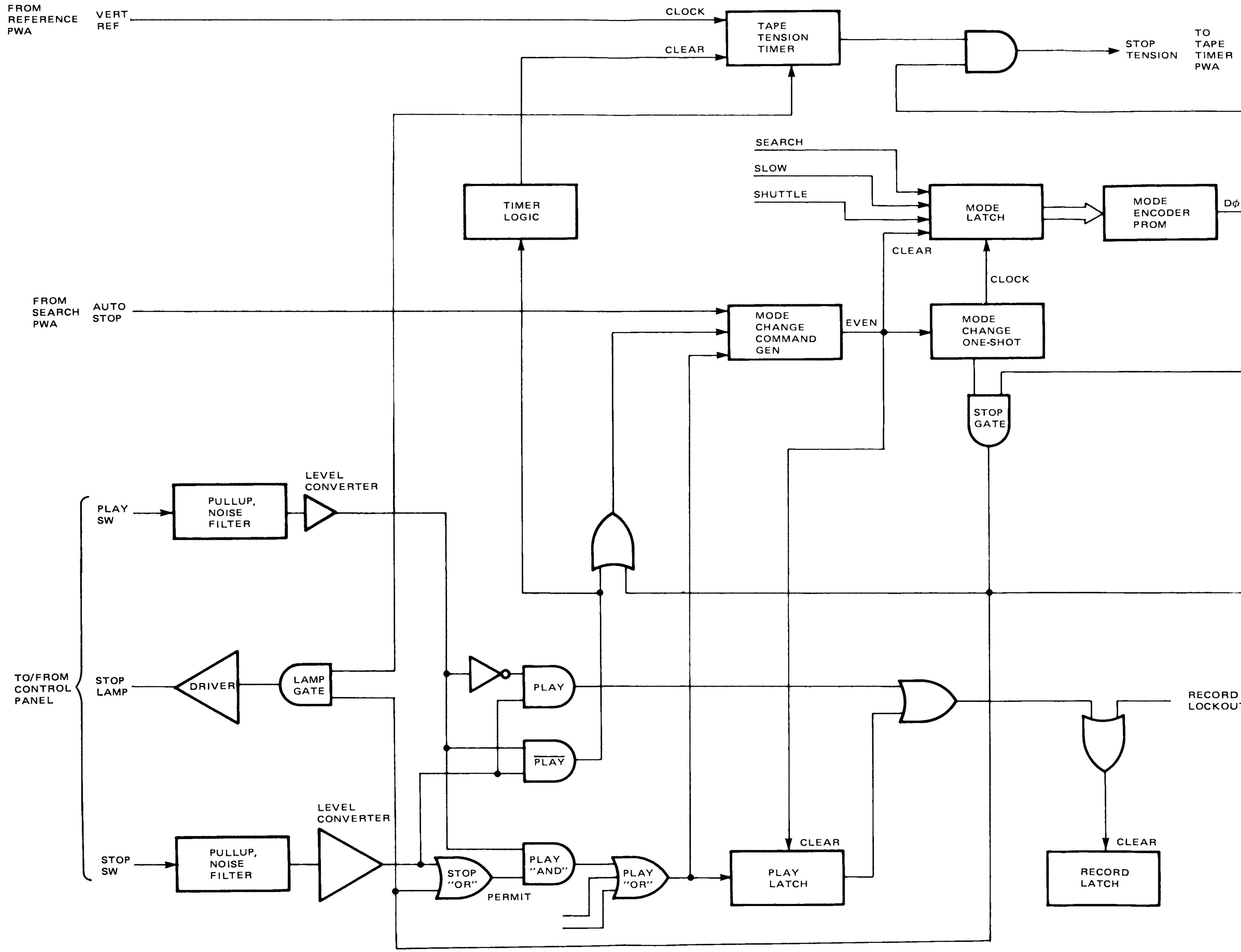


Figure 2-10.
Control PWA Stop Circuit

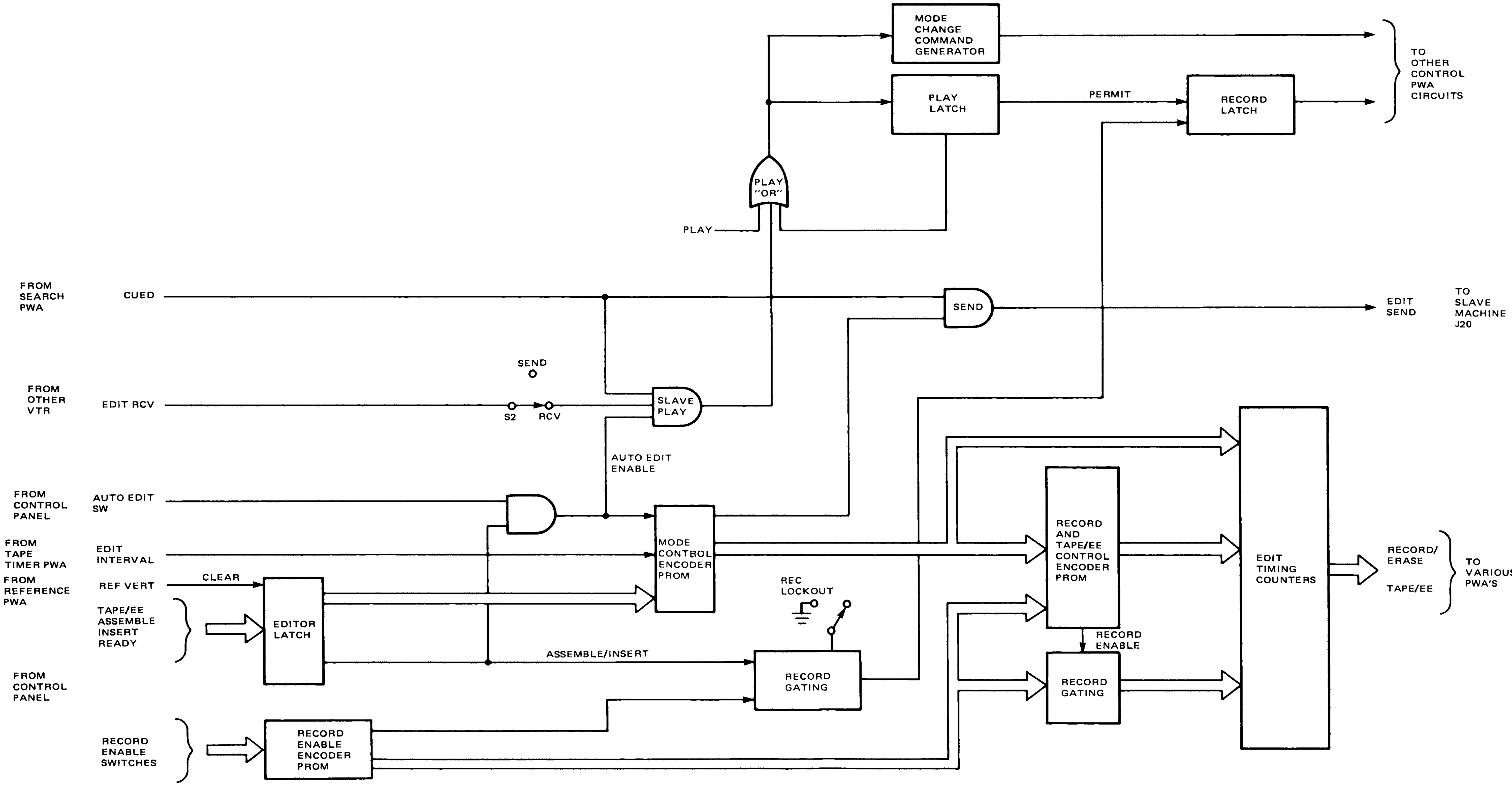


Figure 2-11. Control PWA Editing Circuit

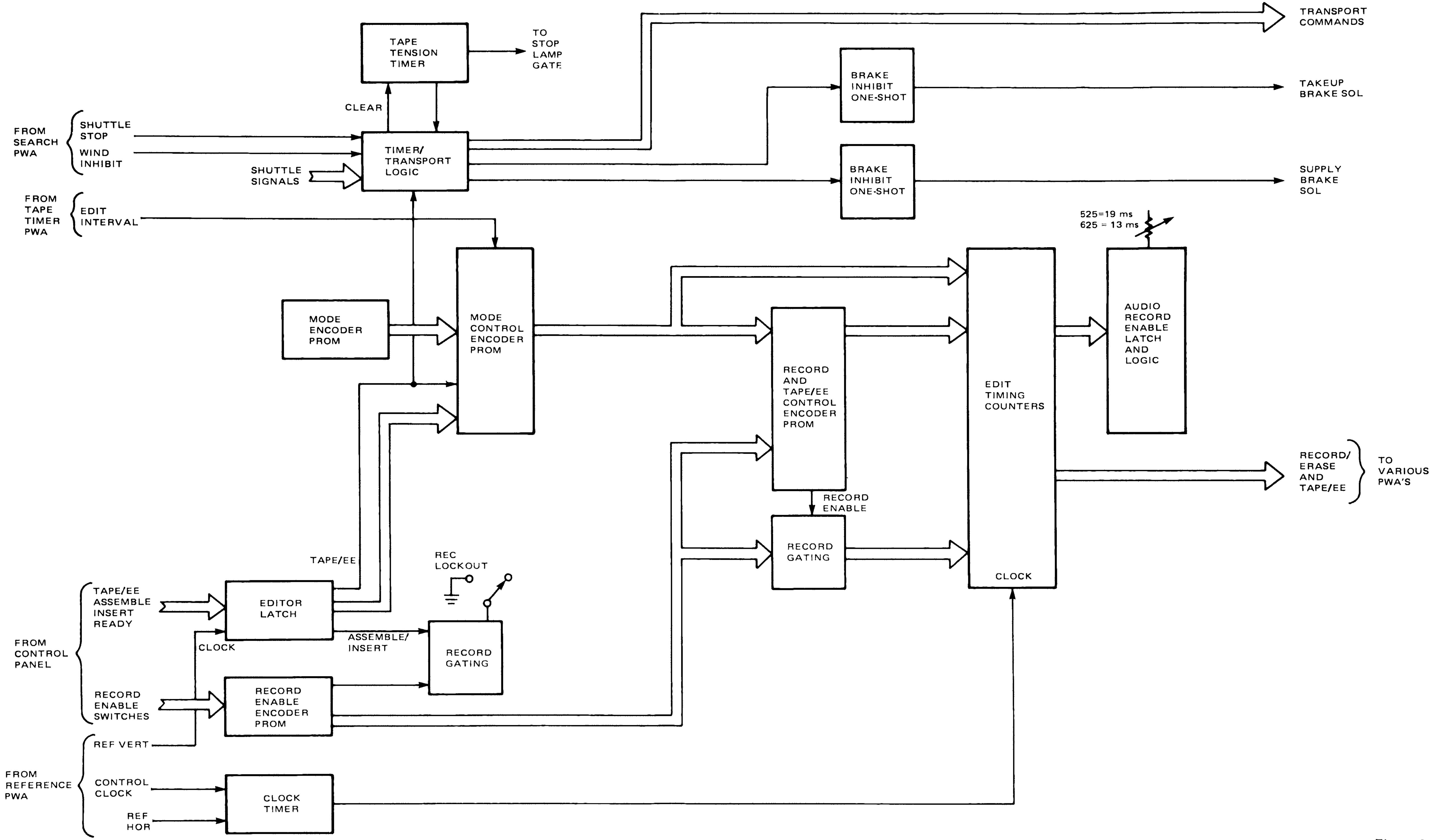


Figure 2-12.
Control PWA EE
Record and Play Circuitry

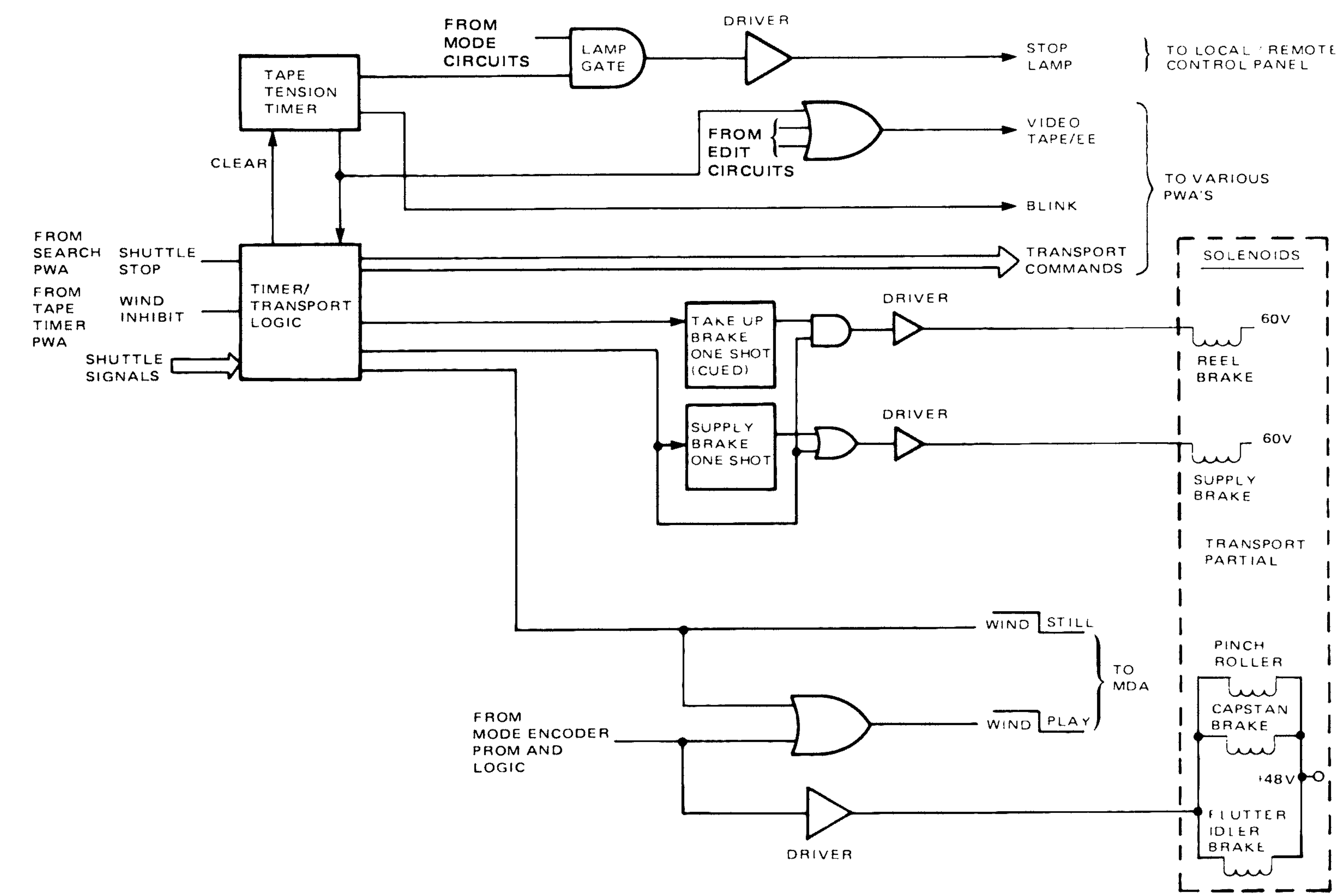


Figure 2-13. Control PWA Still Mode and Solenoid Driving System

inpput of the play "OR" gate. A third play "OR" gate input may be used to activate play mode from editor initiated inputs through the AND gate.

2-27. Record Latch. The record latch is also shown in Figure 2-9. To enter record mode, the play button is held down, and the record button is pressed. The RECORD SW signal is filtered and level converted as with other latches. The signal then couples to the record latch through an AND gate which is enabled when the play latch is set to "play". The AND gate output clocks the record latch. The record latch sets or does not set record mode, based upon its input from the record enable encoder PROM, the record and tape/EE control encoder PROM, and associated logic. If the PROM(s) input requirements are met (RECORD LOCKOUT switch open, one or more RECORD ENABLE switches on, etc.), record mode is set by the record latch.

The PLAY button indicator is inhibited from lighting by the record PROM's via the AND gate. The record latch lights the RECORD button indicator via the lamp driver. In addition, the record latch accesses the play latch through the OR gate to hold the PLAY SW signal active, retaining play mode. Once in record mode, the outputs of the record PROM's and logic drive the necessary circuits to complete record mode.

2-28. Stop Circuit. The VPR is in stop mode when no operational mode is in force. Stop mode may be entered from any other mode by pressing the front panel STOP button. Entering stop mode consists of: (1) clearing the mode latch of all modes; (2) clearing the play and record latches; (3) and clearing the tape tension timer (see Figure 2-10).

Pressing the front panel STOP button produces signal STOP SW – sent to the Control PWA. Here, it is filtered and level converted as with other mode signals. The level converter output arms the play and play AND gates. One AND gate activates its output, depending upon whether play/record mode is not in force, the play AND gate activates, clearing the tape tension timer (through timer logic). It also asserts an input to the mode change command generator (through the OR gate), causing it ot assert its even output. The even output causes the mode latch to clear and clock (via the one-shot) just as with other modes. Assuming no other mode button is being held down, the mode latch latches no-mode, or stop mode. The even output of the mode change command generator clears the play latch directly. The play latch clears the record latch in turn through two OR gates. With a stop mode input, the mode encoder PROM activates its Dϕ output arming the stop gate. Upon mode change one-shot time-out, the stop gate activates to perform four primary tasks: (1) it sustains stop mode to the mode change command generator (via OR gate), (2) it arms the play AND gate, (3) it arms the stop lamp AND gate, and (4) it arms the stop tension AND gate. The cleared tape tension timer enables the lamp gate driving the STOP button indicator.

If play mode is in force when the STOP button is pressed, the following actions take place. The level converter output rescinds the permit signal to the play AND gate, disarming it (via the OR gate). Upon detecting the absence of play input, the mode change command generator forces its even output. This results in the mode latch being cleared and clocked (as described above), capturing stop mode. The even signal clears the play latch. The play latch, in turn, clears the record latch, through the two OR gates. The mode encoder PROM outputs Dϕ, activating the stop gate as described above.

The auto stop circuit operates as follows. The mode change command generator may be accessed directly by AUTO STOP signal, from the Search PWA. When this occurs, the mode latch is cleared and clocked as described above. The even output clears the play latch, which in turn clears the record latch (Figure 2-10).

The VPR allows the operator to go directly from one mode to another by use of the STOP button. This action depends upon another mode signal being present at the mode latch input when the stop button is pressed and released (one of the mode buttons is held down). When this situation exists, the mode latch "captures" the new mode upon being clocked.

2-29. Editing Circuit. One VPR may be used in conjunction with another VPR for editing

purposes. The source (slave) machine supplies material to be recorded by the master machine. The slave's AUTO EDIT switch is set to the OFF position – permitting normal playback. The master's AUTO EDIT switch is set ot the ON position. This permits the master machine to initiate slave machine play mode while the master machine enters the edit-play mode. When in the auto edit mode, master machine operation is of two phases. Initially, it operates in playback. Then, when the tape being edited passes the "edit entrance" point, the master machine switches to record mode, recording the slave machines output.

For the master machine, auto edit operation is enabled when the AUTO EDIT switch is on, forcing AUTO EDIT SW signal, and either the INSERT or the ASSEMBLE switch is on. This condition produces the auto edit enable to the mode control encoder PROM (from the AND gate), as shown in Figure 2-11. The PROM responds by arming the send AND gate, If the master machine is cued (CUED signal true), signal EDIT SEND is output via connector J20 (VPR connector panel) to the slave machine. With the slave's AUTO EDIT switch set to off, and if it is cued, the slave play gate is armed. Receipt of the EDIT RCV signal from the master machine enables the slave play gate, initiating play mode through the play "OR" gate. Note that the slaves SEND/RCV switch (switch S2) must be in the RCV (receive) position.

When the AUTO EDIT switch set to on, the auto edit logic switches the master machine from playback to record (or from playback to EE if the machine is set for an edit rehearsal). This occurs when the EDIT INTERVAL signal (from the Tape Timer PWA) is asserted. This signal commences at the operator selected entrance point, and persists until arrival of the operator selected exit point (if in INSERT mode).

When EDIT INTERVAL arrives, the mode control encoder PROM encodes the edit conditions (from front panel edit switches, via the edit latch) to the record and tape EE control encoder PROM. This PROM correlates these inputs with encoded record enable switch information (from the record enable encoder PROM) to initiate the edit action of the appropriate edit timing counters. This action includes providing record enable to the record gating. The edit timing counters, clocked by a critically timed reference signal, perform precise edit timing for audio, sync, video and erase signals. The record logic sets the record latch to record mode if so allowed by (1) the RECORD LOCKOUT switch, (2) the assemble/insert signal, and (3) the record enable encoder PROM.

2-30. EE, Record and Play Commands. During play mode, setting the TAPE/EE switch to either position results in off-tape audio and video signals being supplied to VPR outputs. In record modes, EE video outputs occur for both switch positions unless the VPR is equipped with AST. When so equipped, the TAPE position yields off-tape video. In the ready mode, TAPE position yields still mode operation.

2-31. *PROM's.* The TAPE/EE SW signal from the control panel switch is latched by the editor latch (Figure 2-12). The editor latch applies the TAPE/EE signal and edit-related signals to the mode control encoder PROM. The TAPE/EE signal is also applied to the timer/transport logic. This logic assesses this input, shuttle inputs, and transport related inputs to the end that it only allows the tape tension timer to accumulate time in the ready, still, slow freeze, or shuttle freeze modes. If so allowed, the timer accumulates time for 3-minutes 20-seconds and then releases tape tension via transport commands (through timer/transport logic). This action protects a motionless tape (under tension) from being damaged by scanner heads scanning down the same track too long.

The output of the mode control encoder PROM reflects the TAPE/EE input, as well as other editor-related inputs and mode status (from the mode encoder PROM). The resulting output goes to the record and tape/EE control encoder PROM , and to the edit timing counters.

The record and tape/EE control encoder PROM monitors the status of all record enable switches, as encoded by the record enable encoder PROM. With the TAPE/EE switch in EE, the record and tape/EE control encoder PROM supplies record enable to the record gating, allowing it to activate the edit timing counter(s).

The record and tape/EE control encoder PROM monitors the status of all record enable switches, as encoded by the record enable encoder PROM. With the TAPE/EE switch in EE, the record and tape/EE control encoder PROM supplies record enable to the record gating, allowing it to activate the edit timing counter(s).

2-32. *Edit Timing Counters.* The edit timing counters provide precisely timed cues for the appropriate channel selections (selected by RECORD ENABLE switches).

Audio cue signals out of the edit timing counters go to the audio record enable latch and logic. This logic incorporates a one-shot fired by an exclusive OR gate sensing arrangement. This circuitry senses audio record "requests" to fire the one-shot which in turn clocks the latch after time out. When so clocked, the latch outputs audio record signals to the BIAS/ERASE and EBU Audio PWA's. The one-shot is potentiometer calibrated for 525 system (19 ms) or 625 system (13 ms) audio edit timing.

The edit timing counters are clocked by the CONTROL CLOCK signal (from the Reference PWA) which has been delayed by the amount of eight reference horizontal (REF HOR) periods The CONTROL CLOCK is a scanner once-around signal.

2-33. Still Mode Initiating and Solenoid Driving System. Still mode is allowed to persist for a limited time (3-minutes, 20-seconds) in order to protect the taut and motionless tape from localized wear by the scanner head. This "time-out" period is controlled by the tape tension timer/transport logic shown in Figure 2-13. Still mode may be brought about in three ways. The second and third ways require that the TAPE/EE switch be set to TAPE position.

1. In slow motion playback, the slow motion shuttle potentiometer is rotated to its detent (center) position.
2. In shuttle mode, the shuttle potentiometer is also rotated to its detent position.
3. In ready state of stop mode, playback occurs.

2-34. *Tape Tension Time-Out Warning.* During still mode the timer/transport logic hcıds the TAKE-UP BRAKE SOL and SUPPLY BRAKE SOL signals true to activate the brake solenoids, holding reel brakes released. The solenoid drivers sink the current from the 60-volt source, through the windings to ground. If the scanner is at normal speed, the timer/transport logic withhoulds clear from the tape tension timer – allowing it to accumulate time. After approximately 3-minutes the timer commences blinking the stop lamp (signal STOP LAMP) through the stop gate and driver. This action alerts the operator that still mode will cease in about 20-seconds. The operator may clear the tape tension timer (if desired) to start time accumulation over.

If in the ready state of stop mode, the operator need only press the STOP button. This action applies the stop signal output (inverted form of the stop gate) shown in Figure 2-6, to timer/transport logic. The logic in turn clears the tape tension timer, preventing it form stopping still mode. The ready latch is not cleared by this action, so thae ready state of stop mode persists. If in slow motion or shuttle freeze, the operator holds the mode button depressed and taps the STOP button. This action momentarily applies the stop signal to the timer/transport logic (as described above) clearing the tape tension timer. The mode in question is reinstated after a few milliseconds.

2-35. *Time-Out Expiration.* If the tape tension timer reaches time-out, it inverts the TAPE/EE signal to the signal system, placing EE in force (through the three-input OR gate). The signal system abandons off-tape video and adopts EE input signal for picture and output video. The timer/transport logic also removes the TAKE-UP BRAKE SOL and SUPPLY BRAKE SOL signals to the respective solenoids, allowing the reel brakes to relax and stop the reels. This action, however, is subject to two sets of conditions. Under "not-cued" operation, the TAKE-UP BRAKE SOL signal is rescinded immediately, applying the take-up reel brake. Eighty milliseconds later, after supply brake one-shot time-out, SUPPLY BRAKE SOL is rescinded applying the supply reel brake.

If signal CUED is in force (from the Search PWA) indicating that the VTR is at the cue point, then both one-shots are fired. The SUPPLY BRAKE SOL signal is rescinded after 80 ms, and the TAKE-UP BRAKE SOL signal is rescinded after 700 ms.

2-36. *Suspending Tape Movement.* When the tape tension timer times out, the timer/transport logic causes tape tension to cease by means of the WIND STILL and WIND PLAY signals sent to the MDA. The WIND STILL signal shifts to STILL. At the MDA, this signal opens the still switch (A13 pins 3, 4, 5). This action opens a path for takeup tension current (signal TU TENSION, from the Search PWA) to the takeup reel drive circuitry. The WIND PLAY signal is shifted to WIND. At the MDA, this signal opens the REV DRIVE (supply motor drive) current path form the Search PWA – terminating reverse drive. It also closes a shunt path to ground for the reverse drive integrator capacitor (C53), dumping drive current.

2-37. Search PWA No. 18

The Search PWA provides two main functions: control of the transport in the rewind and fast forward modes, and control of the transport in the search mode. Transport control is accomplished via forward and reverse drive signals sent by the Search PWA to the MDA Electronics PWA. These signals are pulse-width modulated to control the average motor current provided by the MDA assembly to reel motors.

Other Search PWA functions are takeup reel pack sensing, safety auto stop, and system diagnostics. Refer to block diagram Figures 2-14 and 2-15, and to Schematic Diagram No. 1400185 while reading the description below.

2-38. Shuttle Circuits. Shuttle mode circuitry compares the front panel variable speed control setting with the tape velocity and direction of motion to provide the appropriate pulse width modulated signals to control the transport. Shuttle mode circuits are used in the search mode, under control of the search mode circuitry. Shuttle circuits are described below.

2-39. *Speed Compare Circuit.* Shuttle speed and direction is controlled by the front panel shuttle potentiometer. The shuttle potentiometer voltage is applied to the voltage converter (Search PWA, Figure 2-14). The buffered shuttle potentiometer voltage is applied to the counterclockwise and to the clockwise amp, and to the shuttle direction detector circuit. The shuttle direction detector determines whether a forward or a reverse condition exists, based upon the polarity of its input from the voltage converter. The shuttle direction detector in turn enables the appropriate portion of the direction logic (via the switch) to allow tape movement (in shuttle). Both the counterclockwise and the clockwise amp compare the input voltage to a positive reference, established by their respective counterclockwise CAL and clockwise CAL potentiometers. These potentiometers are calibrated such that, with the front panel shuttle potentiometer set to mid position, neither the counterclockwise nor the clockwise amp provides sufficient output to forward bias the diodes present in their output lines. Turning the shuttle potentiometer counterclockwise causes the counterclockwise amps output to become more positive – forward biasing the diode, and presenting an input to the error comparator via the shuttle voltage switch. The shuttle voltage switch contacts are closed when signal $\overline{\text{WIND}}$ is true, denoting shuttle mode is in force. Note that the search voltage switch is open during the shuttle mode, being inversely controlled by the $\overline{\text{WIND}}$ signal. The counterclockwise amp has a resistor/diode/zener network in its output which affords fine reverse motion control at low speeds.

In a similar manner, as the shuttle potentiometer is turned clockwise, the clockwise amp output increases, forward biasing the output diode, and providing an output to the error comparator via the shuttle switch. At this time, the counterclockwise amp output ceases. Thus, an analog signal is input to the error comparator (portion of the pulse-width modulator circuit) when the shuttle potentiometer is turned past mid-point in either direction.

2-40. *Pulse Width Modulator.* This circuit produces a pulse-width modulated signal which is sent to the MDA (via direction logic) to control takeup or supply reel motor voltage. The direction logic

channels this signal to the proper REV or FWD output line based upon the state of the shuttle direction detector output. The analog voltage supplied to one side of the error comparator (representing shuttle potentiometer position) is compared to an analog signal representing tape speed. The tape tach signal is converted to analog form by a circuit made up of a one-shot, an integrator, and a buffer circuit. It is here that velocity is calibrated by the VEL CAL potentiometer. The output from error comparator is supplied to pin 9 of device A48. A48, pin 10 accepts a reference ramp signal from the ramp generator. The ramp is reset by REF VERT (vertical rate 50 or 60 Hz) from the Reference PWA (via the pulse former). The output of comparator A48-8 is a variable duty cycle waveform which results from the velocity error voltage slicing the reference rate ramps. As the velocity error changes, the duty cycle of A48-8 changes. This output waveform is applied to the direction logic. The direction logic output passes to shuttle logic, shown in Figure 2-15, before going to the MDA.

2-41. *Shuttle Logic.* The pulse-width modulated forward and reverse drive signals are applied to the shuttle logic (Figure 2-15). from circuitry shown in Figure 2-14. The FWD/REV signal (from the Tape Timer PWA) is used to decelerate the tape when a transition is made from shuttle or search to another mode (play, for example). The shuttle logic is enabled when (1) the SCANNER TACH PULSE signal indicates that the scanner is rotating, (2) the SHUTTLE or SEARCH signal is true, and (3) PLAY is not in force. The pulse-width modulated drive signals, thus enabled, are routed to the reel drive portions of the MDA.

2-42. Search Mode. This mode, activated by the SEARCH button (front panel), initiates search to a previously determined cue point. The tape stops at the cue point, or at a selected preroll point.

2-43. *Entrance Counter.* The location of a cue is established when the operator presses the front panel EDIT ENTRANCE button. This action activates the ENTRANCE CUE MARK signal, via the TAPE Timer PWA to load zero (plus the preroll value) into the entrance counter (Figure 2-14). The preroll value is from the preroll logic and preroll selector. Prerolls of 0, 33, and 150 (NTSC/PAL-M) or 175 (PAL/SECAM) frames may be selected. The pre-roll value determines how far ahead of the cue point the transport stops upon completion of search.

The entrance counter is clocked by the ADD 1 signal from the Tape Timer PWA. The ADD 1 signal is basically derived from the tape timer tach and will have a tape frame rate frequency at play or record tape speeds. The FWD/REV signal (from the Tape Timer PWA) indicates direction of tape motion, and is one input to the counter and search direction logic. A second input is the detection of a zero count from the counter. This logic causes the counter to count up as the tape moves away from the cue point, and conversely, to count down as the tape moves toward the cue point. Thus, the counter logs the distance from the cue point without regard to direction.

2-44. *Search-to-Cue.* The search-to-cue action is that of reversing tape motion and proceeding until the value in the entrance counter has returned to zero. If a preroll value has been entered, the tape will search to preroll point. When the front panel SEARCH button is pressed, activating SEARCH signal from the Control PWA, several things happen. The SEARCH indicator on the front panel commences blinking (via the search logic, Figure 2-14). The search direction latch is clocked. The direction logic then examines its inputs to determine in what direction the tape last moved with respect to counter zero (0), and generates opposite search direction commands. This reverses transport direction, to return it to the entrance point. Since the WIND signal is withheld during search mode, the shuttle/search switch, the shuttle voltage switch, and the search voltage switch have reversed positions with respect to shuttle mode. Pulse with modulator circuit action is identical in both search-to-cue and shuttle mode. However, the analog error voltage provided to the current-to-voltage converter derives from the search circuitry.

The analog error voltage is based upon the value present in the entrance counter at any given time. This binary value is converted to an error voltage by the D/A (digital-to-analog) converter and the search current-to-voltage converter.

The search current-to-voltage converter incorporates a close detect circuit which serves to output a constant voltage when the counter value is high (tape is far from cue point) and to reduce output, slowing shuttle speed as the tape approaches the cue point. This approach-ballistics control allows rapid yet accurate search to cue. This action prevents overshooting of the cue point. This overshoot protection also incorporates the close switch (two parts) which allows for fine calibration of the slowing action, using the FWD or REV potentiometer, depending upon direction of cue.

When the counter value equals zero, the reel motors stop. The cued condition is detected by the cued detector and the CUED command activated to the Control PWA. The search logic causes the SEARCH indicator (front panel) to blink during search (using BLINK signal from the Control PWA), and to light steadily when cued.

2-45. *Control System Safety Interlocks.* Certain circuits present on the Search PWA perform control functions. These safety interlock circuits produce AUTO STOP, SHUTDOWN, and CRASH signals. AUTO STOP, sent to the Control PWA, clears the mode latches, excluding the ready latch. SHUTDOWN sent to the Control PWA, cancels the ready mode and clears all mode latches. CRASH is asserted when the tape has come off the reel during a shuttle mode. It goes to the MDA to drive the tape reels to a stop. Also, it goes to the Tape Timer PWA to zero the tape timer counter and to clear other functions.

2-46. *Safety Sense Circuit.* The AUTO STOP command may be produced under the following circumstances:

1. EOT (end of tape).
2. No tape motion (NO TU REEL TACH's) while searching or shuttling
3. While decelerating in reverse and tape tension is lost. (If this condition endures for about 400 ms or more.)

In the first case, an active EOT SENSE signal is buffered by transistor Q1, before asserting AUTO STOP directly via an OR gate. EOT also activates SHUTDOWN command via AND gate A19-4.

In the second case, a loss of tape tach signals causes the tape motion detector (a 1-shot) to retire its output, informing the safety sense 1-shot that tape motion is lost. After about a 400 ms delay, the safety sense circuit's output is passed by an AND gate (armed by a high SHUTTLE command) assert AUTO STOP. In the last case, AND gate A29-3 is armed by command REV/FWD (pin 68) being in the REV state. If tension arm tension is lost, the output of A29-3 goes active, firing the safety sense 1-shot through an OR gate. After about 400 ms delay, command AUTO STOP is forced to the Control PWA.

Besides being activated by EOT (as described above), the SHUTDOWN command may be initiated by a stalled scanner (command SCANNER STALL active) or by an active POWER RESET command from the Control PWA. Power reset (when it occurs) clears most functions of the Search PWA. SHUTDOWN goes to the Control PWA, where it shuts down the machine, clearing modes, releasing tape tension, and shutting off motors.

The scanner interlock circuit prevents shuttle or search tape motion from occuring until the scanner has achieved a minimal speed. This action prevents tape damage.

The scanner speed detector employs a 1-shot which is fired by the SCANNER TACH PULSE signal (trailing edge). The detector's latch is clocked by the leading edge of the signal. As long as the period between tach pulses is greater than the 1-shot time out-period, the circuit remains inactive. When the period between tach pulses is less than the 1-shot time-out period (indicating scanner speed is acceptable) the wind latch is set, thereby enabling forward and reverse drives.

2-47. *Reel Diameter Measurement Circuitry.* The diameter of the takeup reel tape pack is determined by comparing the TAPE TACH signal with the once-around TU REEL TACH signal, from the takeup reel tach optical switch. This circuitry performs two tasks:

1. Tape Tension. The tape tension circuit (Figure 2-15) maintains constant takeup tape tension over the full range of takeup reel pack diameter. This is true for play, record, slow, and still modes. The TU TENSION REFEENCE analog signal produced is sent to the takeup reel MDA. Here, it is summed with the forward drive voltage (FWD DRIVE) to influence reel pull. The voltage varies with the size of the takeup reel pack.

2. Slow Speed Shuttle. The circuit reduces rewind shuttle speed from 300 ips (inches-per-second) to 200 ips when the takeup reel pack diameter is very small, indicating end-of-tape is near. The resulting SLOW SHUTTLE SPEED CMD signal is sent to the MDA to slow the wind speed.

2-48. *Tape Tension.* Signal TAPE TACH clocks the tach counter (Figure 2-15). As the counter accumulates counts, its outputs go true in binary fashion. Arrival of the TU REEL TACH signal from the takeup reel (via tach amp and TU logic) clocks the tach latch, causing it to latch this binary value. At the same time it zeroes (resets) the tach counter – preparing it for the next cycle. The tape tach pulse count reached in the interval between the reel tach pulses is an analog of the takeup reel diameter. A high count indicates a large takeup reel tape pack.

The tach latch output is applied to a resistor network digital-to-analog converter (D/A). The D/A analog output voltage is amplified (TU amp) and sent to the takeup reel MDA as signal TU TENSION REFERENCE. This signal modifies reel pull as described above. Jumper J5 affects normal/fast tension response (normal when in). In the reverse mode, the TU amp is accessed directly by the REVERSE JOG SW signal to relieve takeup tension, allowing the reel to be pulled backwards.

2-49. Slow Speed Shuttle. Lines from the tach counter are also applied to the small takeup reel sense circuit. As long as the BCD value is high enough with respect to the takeup reel tach (which clocks the circuit), signal SLOW SHUTTLE SPEED CMD is withheld. When the count falls below a certain value (indicating the reel is turning excessively fast), the SLOW SHUTTLE SPEED CMD is output to the MDA. This signal causes the MDA to reduce drive voltage available to both the supply and takeup motors – slowing them down, and protecting the tape from runoff damage.

2-50. *System Diagnostics.* The Search PWA contains three LED's to indicate system abnormalities (Figure 2-15). Gating exists to light the front panel SYSTEM LED if one of the PWA LED's is lit. The LED's are lit by signals from the Regulator PWA or from the SPOT REEL switch. Also, a SYSTEM bus signal from another PWA serves to light front panel SYSTEM LED when activated.

2-51. Tape Timing

The tape timer system (Figure 2-16) consists of the timer idler assembly (embodying the tape tachometer), the Tape Timer PWA, and the timer readout assembly. The timer idler assembly is in the tape path, on top of the transport assembly. The timer readout assembly resides on the control panel, upper right corner. The Tape Timer PWA resides in the electronics bay. The tape timer system displays the elapsed time since the tape departed from a zero reference point. The elapsed time is displayed in units and tens of frames, seconds, and hours. The zero reference point is established by the control panel RESET button, or upon application of system power.

2-52. Tape Tachometer. The tape timing action originates with the tape tachometer shown in Figure 2-16. The idler (not shown) turns the slotted disc when caused to rotate by moving tape. The disc's inner and outer rows of slots are offset from each other by ninety degrees. The optical switch detector assembly has two LED/phototransistor pairs, one for each row of slots. One phototransistor provides tach signal $\phi 1$, and the other provides $\phi 2$ to the Tape Timer PWA. The phototransistors are covered by an overlay having a seven-mil slot in it.

2-53. Tape Timer PWA No. 19. This PWA provides an electronic representation of tape movement with respect to direction and position. It receives pulses from the tape driven tachometer portion of the timer idler assembly. It processes this information to provide display signals for the time readout assembly. The buffers portion of the PWA (shown in overall diagram Figure 2-17) can also accept display information from the Time-Code Reader/Generator PWA – destined for the Time Readout Assembly. The choice of information to be displayed is under control of Time Code Reader/Generator PWA (when it is installed). The Tape Timer PWA also supplies direction and speed information to the control system.

2-54. *Overall Operation.* Figure 2-17 is an overall block diagram for the Tape Timer PWA. Circuit operation resides in three different areas. Each area is shown by its own block diagram (Figures 2-18 through 2-20), as well as by Figure 2-17.

2-55. *Direction Circuit.* This circuit (Figure 2-18) detects the direction of idler rotation (and thus tape movement) and advises tape timer circuitry, as well as other PWA's. The relationship of high-to-low going signals between the $\phi1$ and $\phi2$ tach signals is distinctly different for clockwise and counterclockwise idler rotation. The tach signals are treated by the 2X clock and the memory logic and applied to the tach processor PROM. The PROM detects the rotational direction difference and applies it to the REV/FWD delay and storage circuits.

The storage circuit awaits 10 μs time-out of the REV/FWD delay circuit (a one-shot) before asserting the REV/FWD signal. This signal, properly timed, is sent to the Search, Time Code Reader Generator, Control Track PWA's, and to the MDA' It also goes to logic gates and buffers of the Tape Timer PWA.

One output of the REV/FWD delay circuit routes to the tach delay and ÷2 circuit. This line fires the tach delays one-shot, after REV/FWD delay time out. This additional delay of the tach circuit (over that of the REV/FWD delay circuit) insures that a change of direction will always occur (if tape changes direction) prior to a TAPE TACH pulse.

2-56. Tape Tach Circuit. This circuit (Figure 2-18) processes tachometer signals from the timer idler assembly to produce the velocity TAPE TACH and frame identification ADD-1 signals required for VPR operation.

At normal record speed, the $\phi1/\phi2$ tachometer rate is 150 Hz.The 2 X clock doubles this frequency, and the memory logic, and tach processor PROM divide the result by 10 (60 Hz) or by 12 (50 Hz) producing the 2 X tach rate signal ($\phi1/\phi2$ tach divided by 5).

The signal is applied to a delay one-shot, firing it. The one-shot output clocks the direction storage latch, the control track sync storage latch and the 4-bit counter directly. After time-out (about 10 μs), it clocks the memory logic and fires the tach delay and pulse generator one-shot. The tach delay one-shot output clocks the ÷2 circuit whose output provides the 150 Hz TAPE TACH signal. It also goes to the ADD-1 AND gate, generating the tape frame rate. ADD-1 signal when allowed by the tach divider 4-bit counter (divide by 10, 60 Hz, divide by 12, for 50 Hz.

The tape tach circuitry effectively neutralizes the effect tape slippage or tape stretch has on tach position resolution. This is accomplished by means of the control track sync logic, working with the tach divider PROM and 4-bit counter (Figure 2-18). Together, these circuits form a high resolution position tach.

The control track sync logic is made up of two D latches. One is clocked by the CONTROL TRACK PULSE signal, and the other by a 2 X tach (or field) rate signal. The tach divider PROM is programmed such that it "knows" the number of 2 X tach pulses which should occur per CONTROL TRACK PULSE. To this end, the PROM accumulates 2 X tach counts by means of its feedback lines through the 4-bit counter (lines A0-A3.

If the control track slips ahead of tape tach (tach count too small), indicating tape slip, the PROM notes the event. Each successive "slip event" is noted in the same manner – through feedback lines. Once the slip value achieves a certain value, the PROM enables an "extra" ADD-1 pulse through the AND gate at mid-field time. This

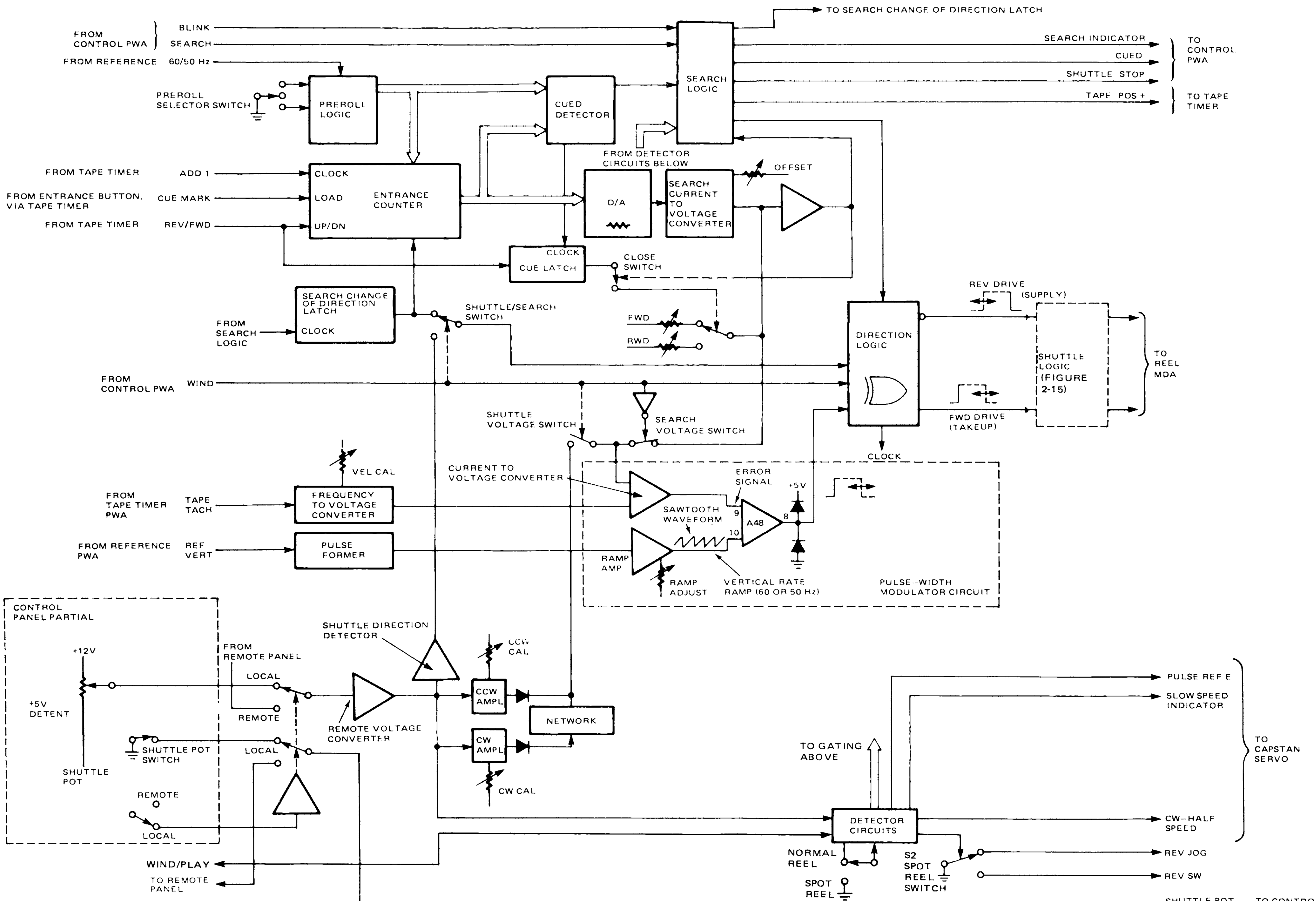


Figure 2-14. Search PWA — Search Servo and Shuttle Servo

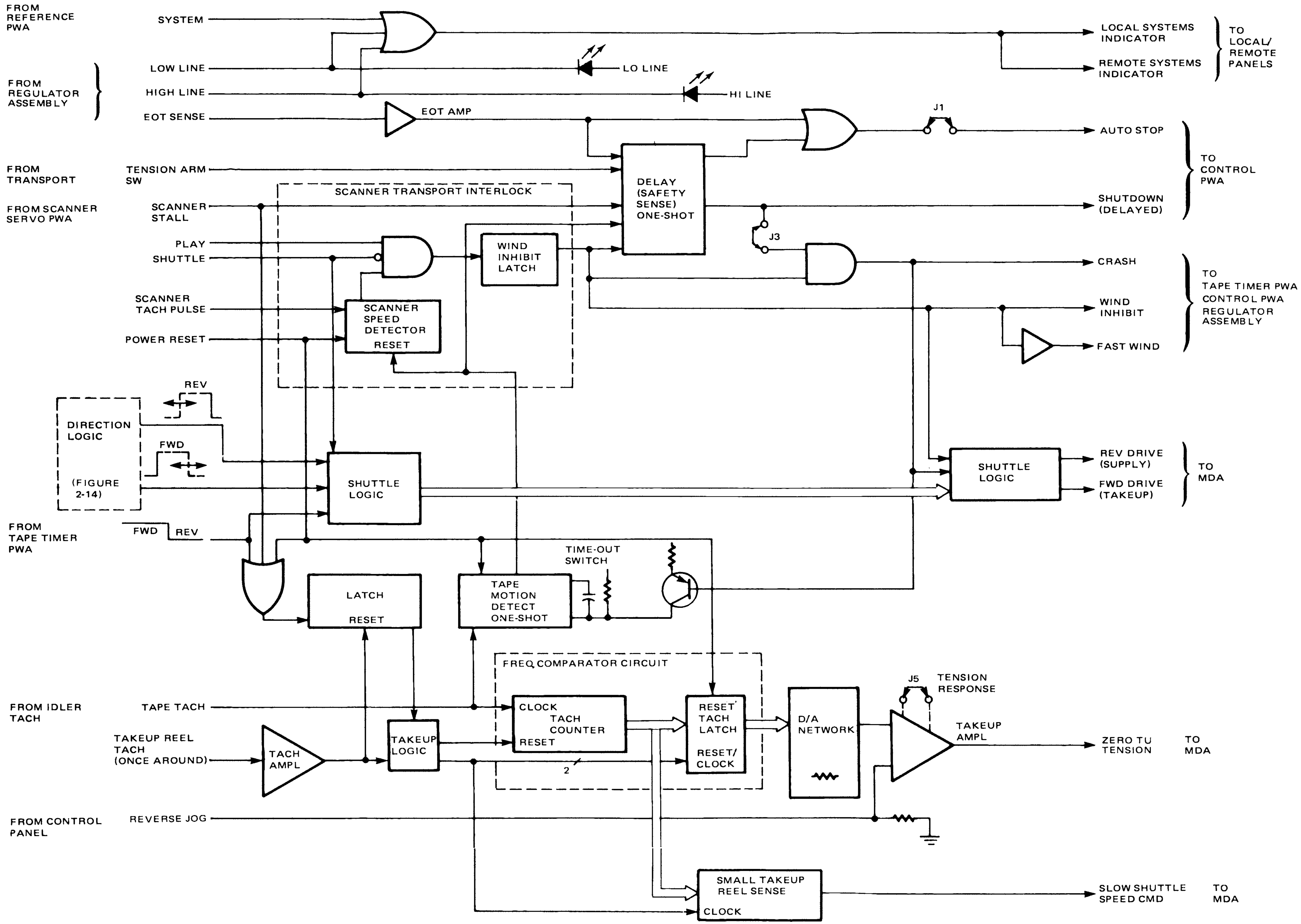


Figure 2-15. Search PWA, Reel Control

action keeps the Tape Timer PWA, Search PWA and other circuitry in step with actual tape movement.

If tape stretch (or stretched tape) is experienced, an excessive number of 2 X tach signals are accumulated with respect to CONTROL TRACK PULSE signals. The PROM notes this, and all successive "stretch events". When sufficient "stretch events" are accumulated, the PROM withholds the ADD-1 signal by inhibiting the AND gate for one field period. If stretch is great enough, the ADD-1 signal may be corrected at a CONTROL TRACK PULSE rate. In either of the above situations, the actual number of frames (not apparent tape movement) is used to keep the system in step.

2-57. Modulus Generator and Look Ahead. The VPR tape timing action is that of storing a value (denoting tape time expired) in a shift register, and circulating it through an adder/subtractor. The adder/subtractor (see Figure 2-19) increments or decrements the value according to ADD-1 pulses received, and to the reverse or forward condition (REV/FWD). The resulting value for each of the eight digits of frame/seconds/minutes/hours display is sent to the Time Readout Assembly over a 4-bit data bus. A 4 X 8 bit shift register at the tape timer output provides the four bits required for all eight digits.

The modulus generator and look ahead circuits job (in the tape timing action) is to:

1. Monitor and control information (4-bits) present at the shift register output at any given time.

2. Determine what information is present at the input to the 4-bit adder and logic (Figure 2-19).

The modulus for each of the eight time digits is different. The following listing expresses the forward operation modulus for all eight digits. Exceptions for PAL/SECAM are shown in parenthesis.

Frames;	units —	modulus 10 (0-9, may be 4 in PAL/SECAM)
	tens —	modulus 3 (0-2)
Seconds;	units —	modulus 10 (0-9)
	tens —	modulus 6 (0-5)
Minutes;	units —	modulus 10 (0-9)
	tens —	modulus 6 (0-5)
Hours;	units —	modulus 10 (0-9, if tens-hours is 0 or 1.) modulus 4 (0-3, if tens-hours is 0 or 2.)
	tens —	modulus 3 (0-2)

2-58. *Tape Timing.* The tape timing action begins (for this discussion) when the RESET switch (Time Readout Assembly) is pressed. Signal RESET SW (Figure 2-19) passes through the debounce and pulse generator circuits to reset the carry adder and shift register circuits. The display now reads all zeros. The 64H REF CLOCK is divided by 2 to clock the 4-bit counter. The 4-bit counter develops a 3-bit word address which is sent to the modulus generator PROM, and to the look ahead PROM. The word address establishes which of the eight time slots (corresponding to time division multiplexing of eight display digits) is in force at a given time and informs the PROM's of the same. The modulus generator PROM (in turn) presents the correct modulus (for the time slot in question) to the 4-bit comparator. Thus, if the time slot in force corresponds to tens of minutes, the PROM presents modulus five to the 4-bit comparator.

In the presence of no tape movement, and no resulting ADD-1 pulse, the circulating action described above continues with ZEROS only passing through the 4 X 8 shift register, and back around to the 4-bit adder, and two 4-bit comparators.

2-59. *Forward Tape Movement.* Assuming the tape is moving forward, and an ADD-1 pulse arrives, the carry adder latches the ADD-1 pulse, storing the event. This status persists until the data circulating through the 4 X 8 shift register comes around to the units-frame position. At this time, the carry adder is clocked and it supplies its output to the 4-bit adder and to the 4-bit comparator.

At the same time, the modulus generator PROM is supplying modulus 9 (for units-frames) to the

comparator. The comparator compares this 9 against the zero value (from the shift register) and finds no equality (A does not equal B). The A = B line (not true) directs the 4 X 8 shift register to accept inputs from the 4-bit adder (DO inputs). The 4-bit adder adds one to the circulating data (as instructed by the carry adder), and supplies the result to the 8 X 4 shift register. The 8 X 4 shift register (upon being clocked) latches the new value (BCD-one) into the units-frame position. In addition, the A = B signal (not true) allows the carry clear circuit to activate, clearing the ADD-1 pulse out of the carry adder. With carry missing, the next digit position will not be incremented.

The above described action continues (with each ADD-1 pulse) until the accumulated number for units frames reaches 9 (4 for PAL/SECAM). At this point, the 4-bit comparator receives BCD number 9 at inputs from the shift register, and from the modulus generator. Under such conditions, the 4-bit comparator asserts its A = B output to the 4 X 8 shift register, and to the carry clear circuits. This action initiates two events:

1. The 4 X 8 shift register diverts from its DØ inputs (from the adder) to the D1 inputs (from the modulus generator PROM). The PROM supplies all zeros, which are entered by the shift register into that time slot. The number 94 is dropped.

2. The carry clear relieves clear to the carry adder. The carry adder, thus enabled, instructs the 4-bit adder to "add one" to the next time slot.

Upon arrival of the next time slot (in this case, tens-of-frames), the comparator, observing different BCD inputs, retires signal A = B. The 4 X 8 shift register reverts to its DØ inputs. The 4-bit adder, under carry adder control, adds one to its input form the shift register. Thus, the carry number is placed into the next greater time slot (one-period delay).

The output of the 4 X 8 shift register passes through buffers to be sent to the time readout assembly (both local and remote). The buffers have the ability to be switched such that they can accept display data from the Time Code Reader/Generator PWA, and send same to the time readout assembly. This mode is selected when a Time Code Reader/Generator PWA is installed, and all time and time code data is then generated by the Time Code Reader/Generator PWA.

Note that in the tens-of-frames, the modulus generator is supplying BCD 2 to the comparator. Assuming sufficient ADD-1's have been received, and the units and tens of frames number has incremented to 29, the next ADD-1 pulse will initiate the following (24 for PAL/SECAM) action:

1. Units-frames will clear to zero and a carry passed to tens of frames.

2. Tens-frames position will witness 2 (from modulus generator) compared to 2 (circulating data). The resulting equality (and the carry from units frames) will cause the tens-frames to clear to zero, and the units seconds to advance to one.

The ultimate carry would witness the number 23:59:59:29 (23:59:59:24, PAL/SECAM) being incremented to 00:00:00:00 (all zeros) by the next ADD-1 pulse. This is so because the data for all digits matches the upper limit for every time slot produced by the modulus generator. The upper and lower limit for the group of modules is normally 23:59:59:29 (23:59:24, PAL/SECAM) and 00:00:00:00 respectively. There are exceptions however, in compliance with drop frame requirements, to units-hours limitations, and to units-frames limitations in PAL/SECAM.

2-60. *Reverse Tape Movement.* The subtraction operation is performed in the following manner. When the tape is running in reverse, signal REV/FWD (from the direction latch) declares "reverse operation". This signal instructs the modulus generator PROM to supply a different set of moduli. In reverse operation, the modulus for each digit position states the lower limit, which is normally zero.

In reverse motion, just as with forward motion, an ADD-1 pulse is produced for each frame of tape movement. The carry adder latches the ADD-1

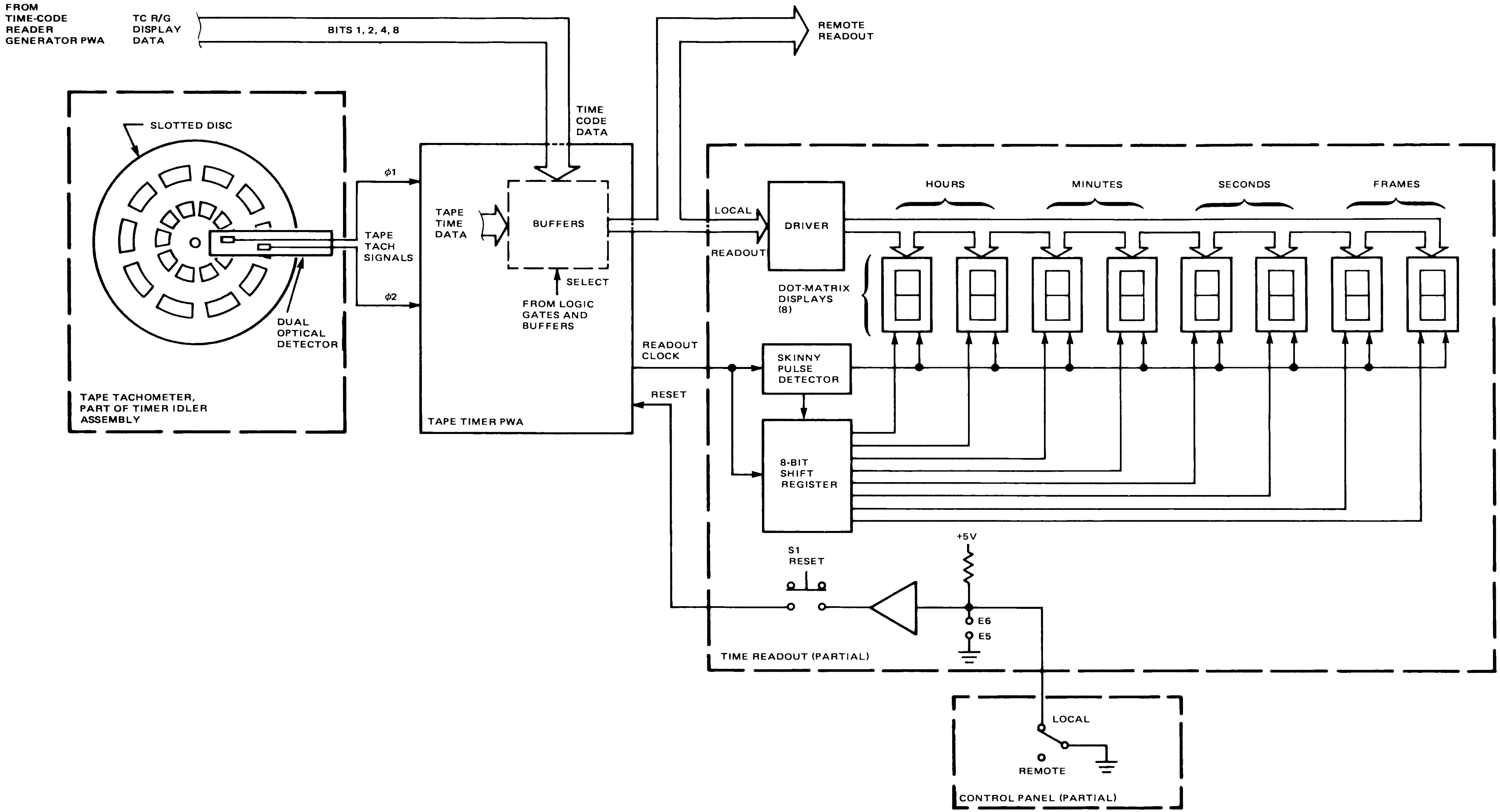


Figure 2-16.
Tape Timer System

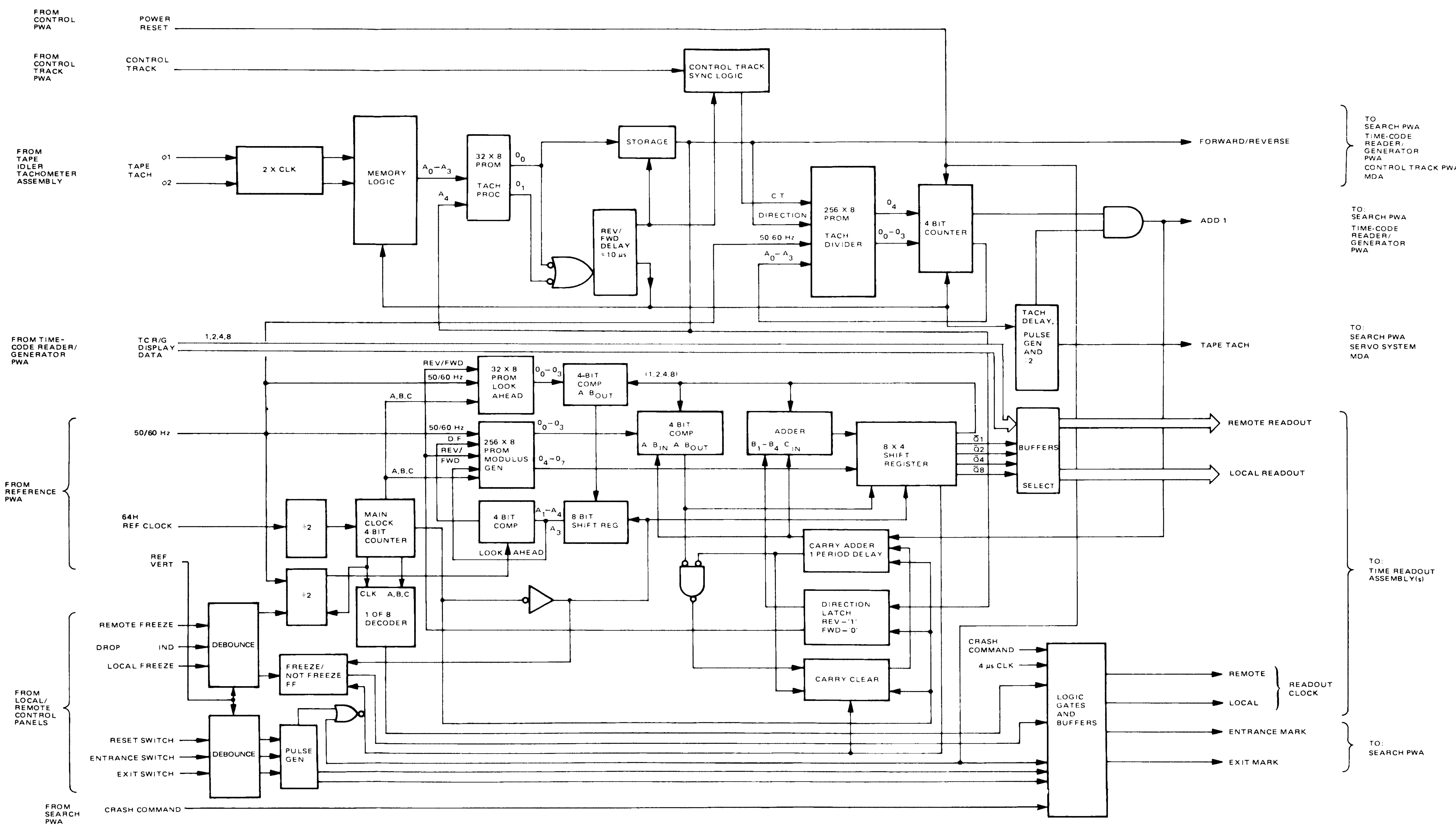


Figure 2-17. Tape Timer PWA, Overall Block Diagram

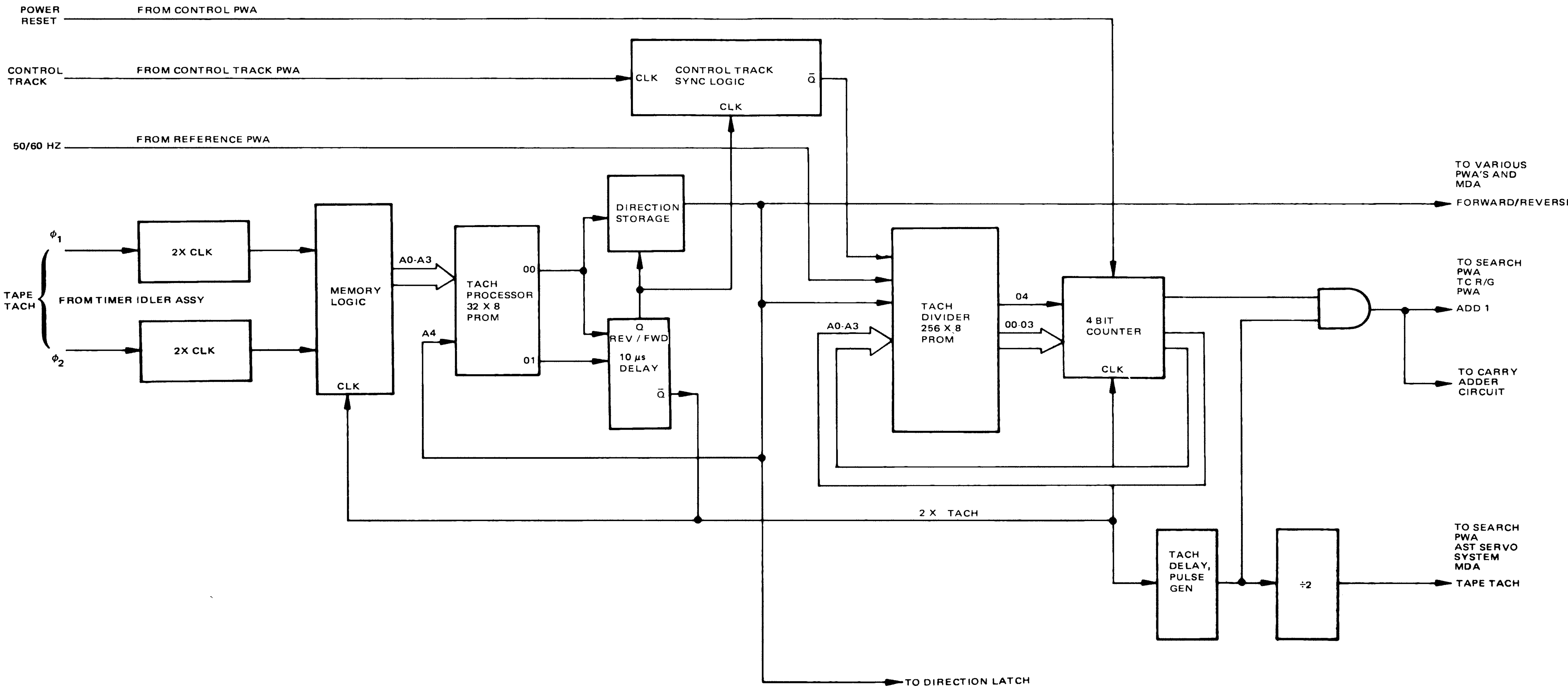


Figure 2-18. Tape Timer PWA, Tape Tach and Direction

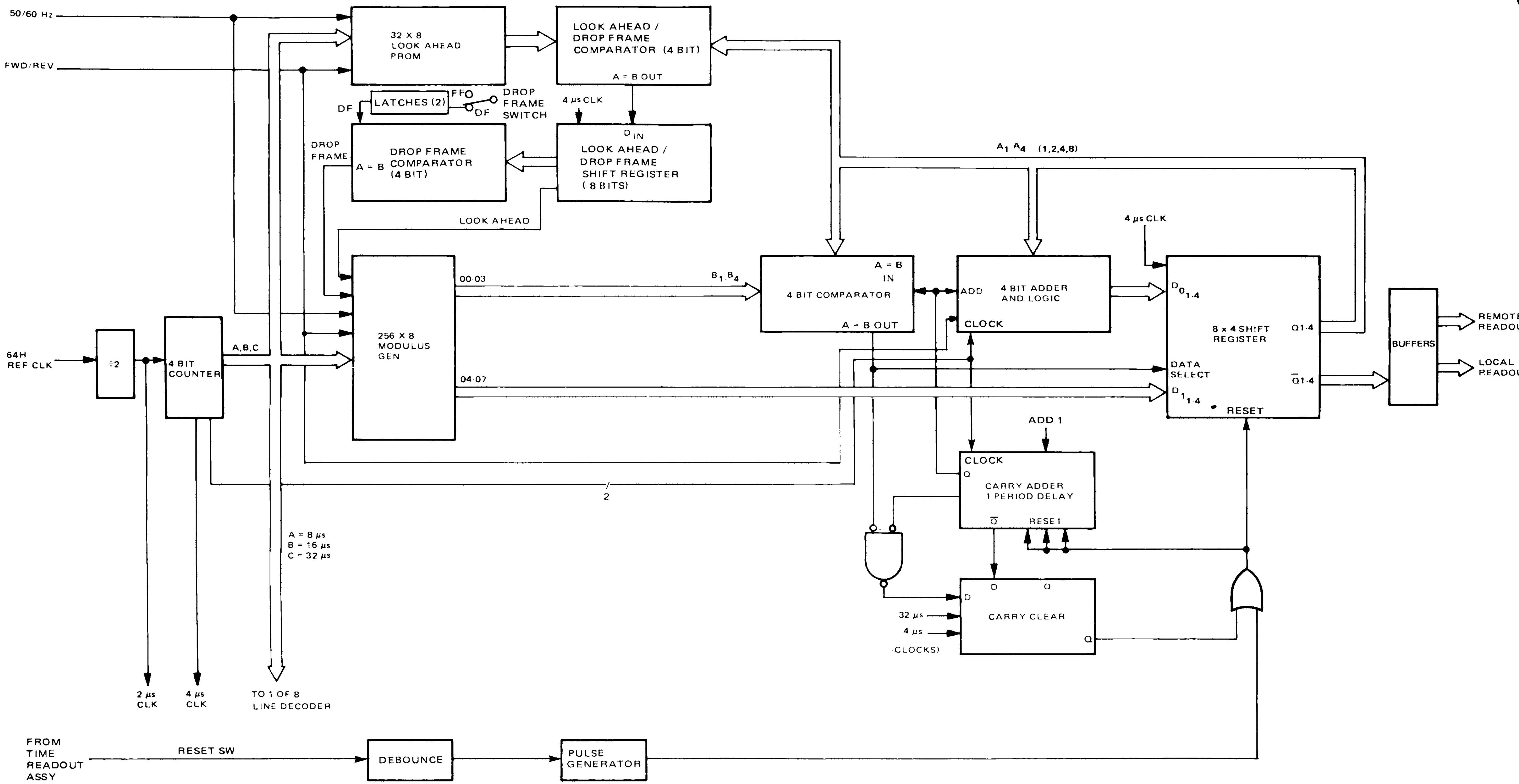


Figure 2-19. Tape Timer PWA, Modulus Generator and Look Ahead

pulse "event", storing it. At units-frames time, the carry adder is clocked – and (in turn) instructs the 4-bit adder to subtract one form the value present at its inputs. The modulus generator PROM is simultaneously supplying the lower limit modulus to the 4-bit comparator. The modulus (zero) is compared to the data value, and if there is no equality (the data is one or greater), signal A = B is not forced. The 4-bit adder performs its subtraction by one, and the 4 X 8 shift register accepts the resulting decremented number when clocked. When the circulating number has decremented to zero, the comparator finds equality between it and the modulus (zero) and forces signal A = B. With its A = B input true, the 4 X 8 shift register diverts to its inputs (D1) from the modulus generator PROM. At this time, the PROM supplies a 9 (4 PAL/SECAM) which the shift register clocks in.

Note that when A = B was true, it did not allow the carry clear circuit to activate. Therefore, the ADD-1 pulse remains in the carry adder. It will serve as a borrow. When the shift register was clocked, the next greater digit position arrived. The borrow (at this time) instructs the adder to subtract. The subtraction will occur and the shift register will accept the result, which, in this case, will be tens-frames has been decremented to zero, the comparator finds equality, and the shift register will accept its tens-frames number (2) from the PROM.

Thus, if the initial eight digit number 00:00:00:00 (as when RESET is pressed), and tape is moving backwards, the next ADD-1 pulse would witness subtraction of units-frames and a borrow passed along until the number becomes 23:59:59:29 (23:59:59:24) PAL/SECAM. The next ADD-1 pulse to occur would produce no equality in the comparator, and the borrow would be cleared.

2-61. Look Ahead and Drop Frame

The look ahead and drop frame circuits accomplish three basic tasks. These are:

1. For NTSC/PAL-M, skipping 0 to 1 and each minute – except at the ten minute interval. This compensates for imprecision in the times-to-frames tally relationship.
2. For a 625 system, limit the units-frame to 4 when tens-frames reaches 2 (24 frames is the upper limit).
3. Anticipation of the upper limit of tens-of-hours, thereby limiting the units-hours to 4 (24 hours is the limit).

There are 29 frames per second and 25 frames per second for 525 and 625 television systems respectively. However, the 29-frames-per-second number (525 system) is not precise. In fact, an error accumulates such that the frames count must be jumped two extra frames once per minute – an exception is the ten-minute interval in which the two-frame jump is abandoned, and frames are counted one-for-one (525 system). This jump activity performed once each minute, for nine-out-of-ten minutes brings the relationship of frames-count to real time into proper alignment. Drop frame operation is not employed in the 625 television system since 25-frames-per-second is precise and needs no compensation. The task of the look ahead PROM differs between 525 and 625 systems, therefore, its programming differs. Drop frame operation for 525 system is described below.

2-62. *Drop Frame, 525 System.* Like the modulus generator PROM, the look ahead PROM (Figure 2-19) outputs a 4-bit word which is unique to each of the eight digit positions. It supplies this word to the look ahead/drop frame comparator. The other side of the look ahead/drop frame comparator receives circulating data inputs from the 4 X 8 shift register. Assuming forward tape motion, the look ahead PROM outputs the upper limit modulus for units and tens of frames and seconds, and units for minutes. Its intent is to identify:

1. When a full minute has expired, and rollover is imminent.
2. When a full ten-minutes have expired, and rollover is imminent.

Each time the look ahead/drop frame comparator finds equality between the PROM data, and circulating data, it forces its A = B output to the look ahead/drop frame shift register. The shift register, in every case shifts this condition in when clocked. The shift register is a serial-in/parallel-out device. This device operates such that after four clock

periods, the compare/not compare conditions for the previous four clock periods are displayed at its output in broadside fashion. Thus, the drop frame comparator can compare units/tens of frames and seconds against hard-wired inputs to determine (at a glance) if 29-frames, 59-seconds (or one full minute) have expired. If comparison is achieved, its A = B output is forced to the modulus generator PROM.

The PROM responds by supplying a BCD number 2 to the 8 X 4 shift register, rather than BCD zero. The next ADD-1 pulse diverts the shift register from the adder to the PROM inputs, and a 2 is shifted in at the next clock. The rollover to the next minute starts off with 02-frames, rather than 00-frames.

The drop frame comparator monitors one additional line from the look ahead/drop frame shift register (this is made possible by the ANDing of two lines into the 4-bit comparator). The "extra" line represents tens-of minutes. In the event tens-minutes found comparison with the 9 supplied by the look ahead PROM (in addition to comparison of lower order minutes/seconds/frames) the drop frame comparator is informed of this fact by the shift register. In this case, drop frame action is withheld from the modulus generator PROM (A = B is not forced) in compliance to the requirement that drop frame be omitted at ten-minute intervals.

2-63. *Reverse Motion Drop Frame.* In reverse motion, the modulus set (partial) which the look ahead PROM supplies to the look ahead/drop frame comparator is:

0-minutes, 00-seconds, 02-frames

As the circulating number is decremented, the look ahead/drop frame comparator finds equality with one or more of the digit positions listed above. If the comparator finds equality (first) with 2 in units-frames position, and then (in sequence) with zero in tens-frames position, zero in units seconds position, and zero in tens seconds position, a one-minute interval has been identified. Just as with forward motion, the drop frame comparator finds equality for all four digit positions, and forces A = B to the modulus generator PROM. Unlike forward motion, the PROM responds by putting out the BCD number 9 (rather than 1). Thus, the extra frame counts that were inserted in forward motion, are extracted in reverse motion, preserving the accuracy of the tape timing process.

Just as with forward motion, the units-minutes digit is monitored to detect a ten-minute interval. When such an interval is detected – as denoted by units-minutes being zero, the drop frame action is withheld from the modulus generator PROM (A = B is not forced). Drop frame operation may be turned off by means of the DROP FRAME switch, located on the Tape Timer PWA front edge, (it is automatically inhibited in 50 Hz operation).

2-64. *Unit-Hours Look Ahead.* During the tens-hours position, the look ahead PROM (Figure 2-19) supplies a 2 to the look ahead/drop frame comparator. If the circulating tens-hours value is 2, A = B is forced to the look ahead/drop frame shift register. This "comparison true" bit advances through the shift register until, during the next units-hours position, it appears at the LOOK AHEAD output line (pin 12). This line, when active during units-hours time, causes the modulus generator PROM to supply three to the 4-bit comparator. If the circulating units-hours value is three but no carry is brought forward from tens-minutes, then rollover does not occur. However, if the circulating value is three, and a carry is brought forward from tens-minutes, then the 4-bit comparator is enabled (A = B IN is true). The comparators A = B output causes the 4 X 8 shift register to divert to its inputs from the PROM, which is supplying zero. During tens-hours time, the carry adder (holding carry from the previous cycle) enables the 4-bit adder. Comparison is found between number 2 from the PROM and a circulating number 2. The resulting A = B comparator output diverts the 4 X 8 shift register to inputs from the PROM, which is supplying a zero. Thus, 24-hour rollover is accomplished leaving all zeros in the shift register.

2-65. Miscellaneous Inputs and Logic.

2-66. *Readout Clocking.* Readout clocking is accomplished by logic gates and buffers, shown in Figure 2-20. The single clock line is sent to the time readout assembly where it is used to

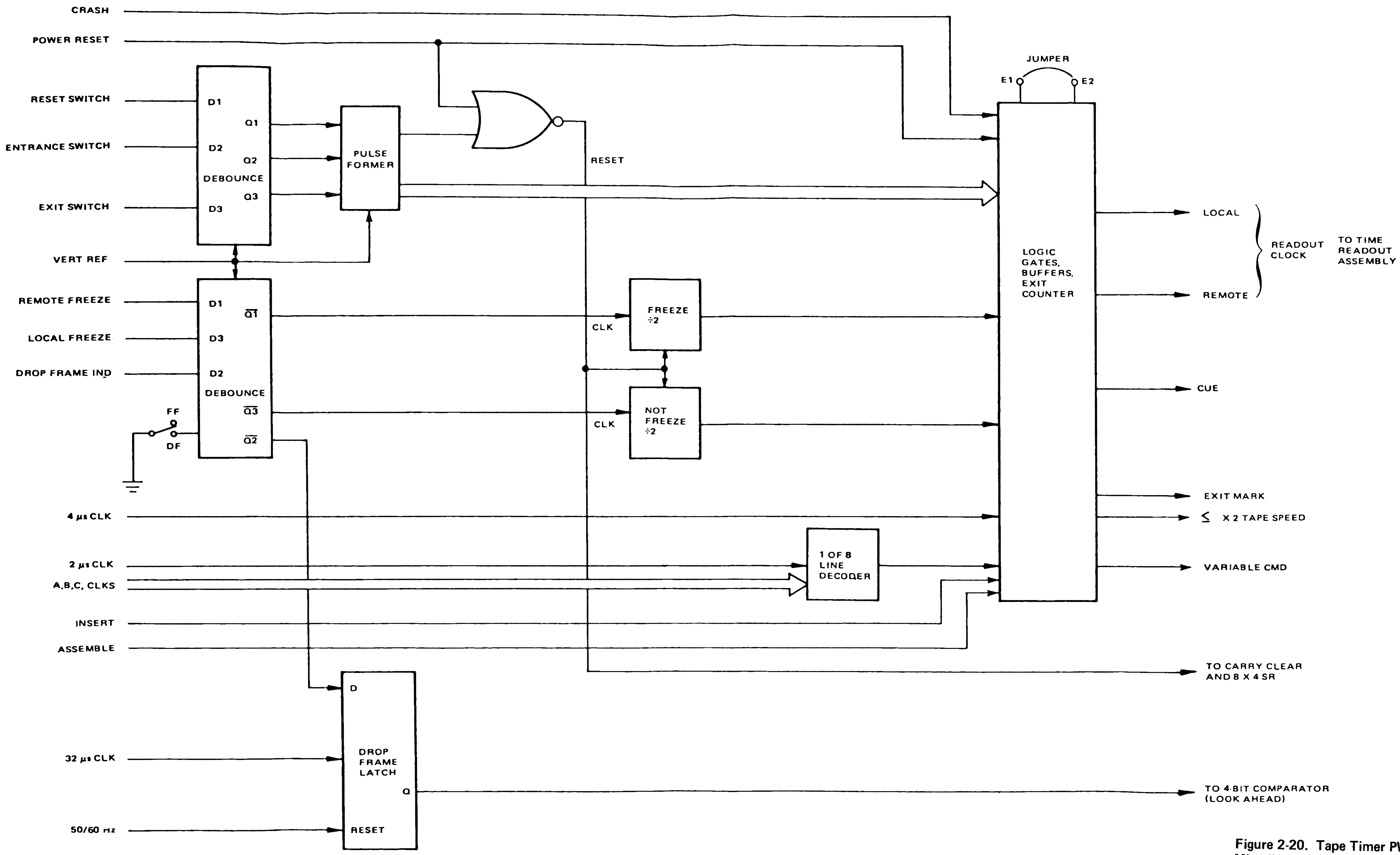


Figure 2-20. Tape Timer PWA, Miscellaneous Inputs and Logic

individually strobe each of the eight displays. One out of eight clock pulses is narrower than the rest. The "skinny" pulse is detected by time readout circuitry to uniquely identify the units-frames position. This pulse determines display phasing. See the time readout assembly description for greater detail.

2-67. *Display Freeze.* A freeze switch on a remote control panel allows the associated local/ remote display to be frozen. Switch input is debounced (Figure 2-20) and applied to a divide-by-two flip-flop. The flip-flop output goes to logic which alternately allows and disallows the readout clock to be transmitted as the button is pushed. The display devices themselves incorporate storage which allows them to retain and display the last digit value strobed into them. Thus, the remote display is "frozen" until readout clock resumes. Pressing the button again aborts freeze mode restoring readout clock.

2-68. *Exit Counter.* The exit counter operates as follows: The EXIT SW signal, activated when the EXIT switch is pressed, is treated appropriately by the debounce and pulse former circuits before being applied to the exit counter (Figure 2-20). This signal causes the counter to load a high value preset number. The counter is an up/down counter counting the ADD-1 pulses. It counts down as tape moves forward, and up as tape moves reverse and counts all the ADD-1 pulses in 90 minutes of tape.

By loading a high value number, the machine can continue moving forward beyond the exit point (with counter counting down) without the exit value being lost.

Upon returning to the entrance point (search-to-cue), signal TAPE POS + from the Search PWA goes high. When the edit commences, TAPE POS + again goes low, the EDIT INTERVAL signal to the Control PWA is forced, advising it to commence edit record. A counter introduces delay into EDIT INTERVAL LED signals (which light local/ remote panel LED's) to compensate for audio erase delays imposed by the control board.

Circuitry exists which will allow the BLINK signal to blink the EDIT INTERVAL LED's 1) an assemble edit is in progress – this action alerts the operator that the exit point will be ignored and that the edit will continue until manually terminated or 2) entrance and exit points are reversed, with the exit point occurring before the entrance point.

2-69. Two-Times Tape Speed Circuit

A portion of tape timer logic monitors tape speed in the play variable and shuttle mode to ensure audio and video integrity. This circuitry evaluates the ADD-1 signal (denoting actual tape speed) against the vertical reference signal (VERT REF). At two-times play speed or signal $\leqslant$ X 2 TAPE SPEED is rescinded. AT the Audio PWA, this signal false-initiates audio muting, cutting the audio at shuttle speeds.

2-70. Time Readout Assembly

The Time Readout Assembly incorporates eight digits of a LED dot-matrix display, and the necessary electronics to drive same. Information displayed may be tape time data from the Tape Timer PWA, or tape time code or user bit data from the optional Time Code Reader/Generator PWA – via the Tape Timer PWA. Figure 2-21 is a block diagram for the time readout assembly.

2-71. BCD Data Latching and Display. The dot-matrix disply devices used in the Time Readout Assembly have the capability to:

1. When strobed, latch and store a BCD data word present at their inputs. A stored word is retained until the next strobe is received.

2. Decode the 4-bit word to drive the dot matrix display.

Four-bit data words from the Tape Timer PWA are buffered and applied to all display digits in parallel (Figure 2-21). Words are received in sequence, from units-frames value, through tens-hours, and the cycle starts over again (at units-frames). During any given digit position time, only the intended display device receives a strobe from the 8-bit shift register – permitting it to latch in the digit value.

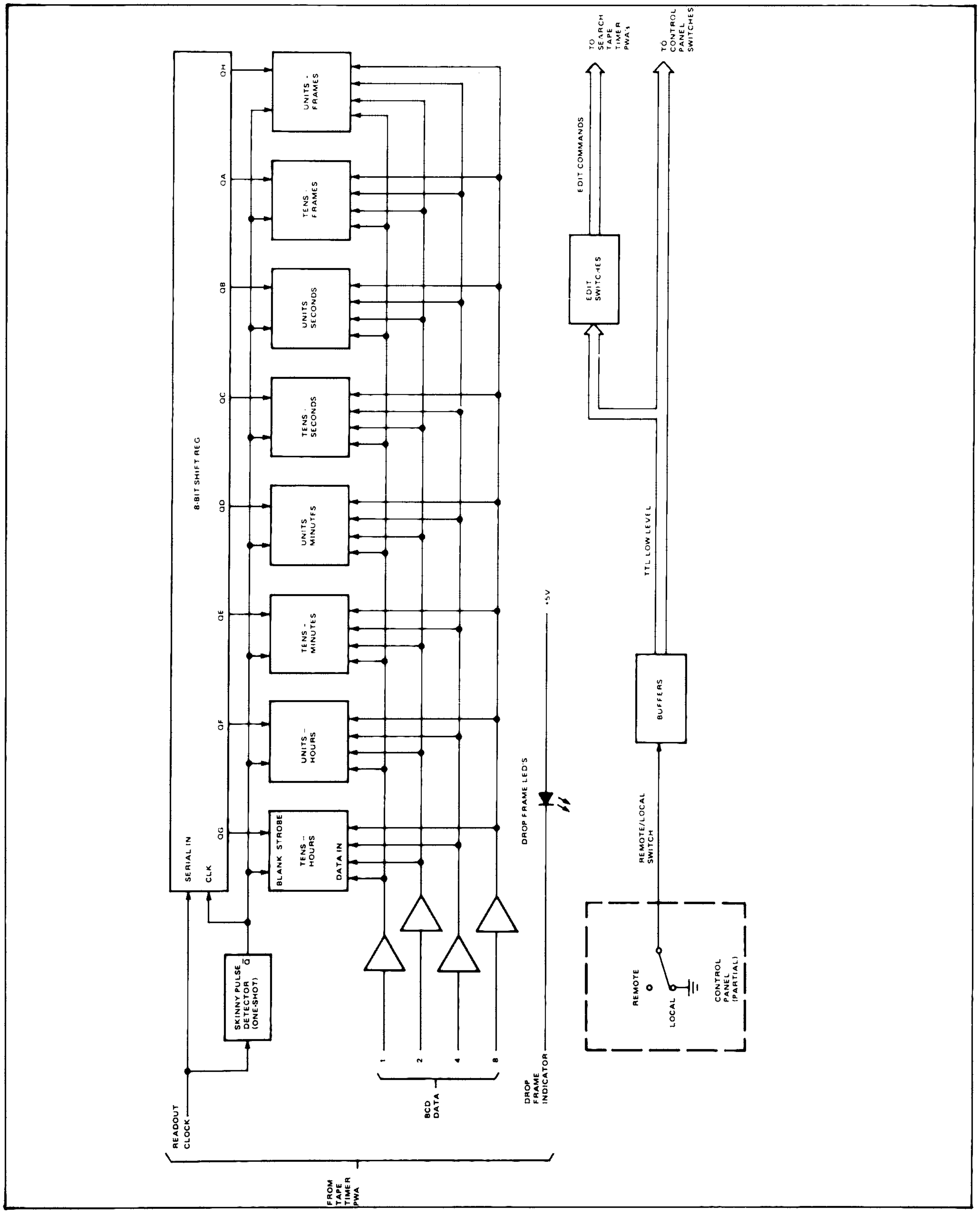


Figure 2-21. Time Readout Assembly

2-72. Readout Clocking. The objective of readout clocking is to strobe each (of the eight) display digit devices in sequence, according to which digit position time period is in force. Display devices are strobed only by the rising edge of their strobe inputs.

Positive-going readout clock pulses are applied to the 8-bit shift register data input, and to the skinny pulse detector – a one-shot. For every clock pulse received, the one-shot is fired. Its Q output goes low, and upon recovery, returns to high clocking the shift register. The one-shot period is less than half that of the positive clock pulses. Therefore, the shift register shifts in the high present at its input at the time of one-shot time-out. However, the clock pulse pertaining to units-frames time is of a shorter duration than the one-shot period. Thus, the shift register clocks in a low at units-frames time, since the readout clock pulse is expired at that time. The low appears at the shift register QA output. The QA output presents this low to the strobe input for the tens-frames display device. Upon arrival of the next readout clock pulse (which pertains to tens-frames time), the shift register clocks in a high and the low level advances from QA to QB output. The positive-going transition of the QA output strobes the tens-frames display device. The display device responds by latching the tens-frames BCD data value present at its inputs.

With each additonal readout clock pulse that arrives, the TTL low present at the shift register output advances to the next higher order Q output, strobing the display devices as it goes. When the low has advanced to the QH output, the units-frames strobe input is armed. The next clock pulse (which begins a new cycle) finds the low departing QH, and the units-frames display device is strobed, capturing the units-frames value.

2-73. Display Blanking. The output of the skinny pulse detector one-shot, besides clocking the 8-shift register, connects to the blanking inputs of all display devices. This blanking signal recurring at a readout clock rate, serves to reduce the display duty cycle. Blanking in this way greatly reduces current drain for the assembly, while preserving display visibility. Blanking is independent of data storage.

2-74. Buffers and Indicators. Local or remote operation for the VPR is affected through buffers which reside on the time readout assembly. If the LOCAL/REMOTE switch (control panel) is in the LOCAL position, a TTL low level is supplied to front panel controls and switches via the time readout assembly buffers – facilitating local machine operation and disabling the remote control panel. Conversely, with the switch in REMOTE, the TTL low level is withheld from the local control panel, and is supplied instead to the remote control panel. Switches pertaining to edit operation (S1, S2, S3, S4) reside in this assembly. Drop frame indicator LED's also reside on this assembly.

2-75. TRANSPORT CIRCUIT DESCRIPTION

2-76. General

The transport circuitry consists primarily of the MDA (motor drive amplifier) assembly. This assembly includes the MDA Electronics PWA, 1400258, the MDA Driver PWA, 1400504, and the Heat Sink PWA 1400500. The MDA assembly receives various analog and digital control signals, and drives the tape supply and takeup motors, the scanner motor, and the capstan motor. The drive currents are controlled as necessary to produce appropriate reel speeds and tape tensions during the various modes of operation.

Block diagrams are presented for each of the five modes of operation. The circuit descriptions for these modes are given at the MDA assembly level. Reference designations (paragraphs 2-77 through 2-81) refer to the MDA Electronics PWA unless otherwise indicated. Refer to schematic diagram 1400258.

2-77. Fast Forward Mode. Figure 2-22 is a block diagram of the MDA circuitry used in the fast forward mode. This mode is initiated when a low drive signal is applied to pin N. A transistor switch (Q9) is turned off, applying −12 volts to a differential amplifier (A6-3). This turns on a current driver (Q001 of the Heat Sink PWA), forcing a negative-drive current (motor current flowing from ground via J5 pins 4/5) through the takeup

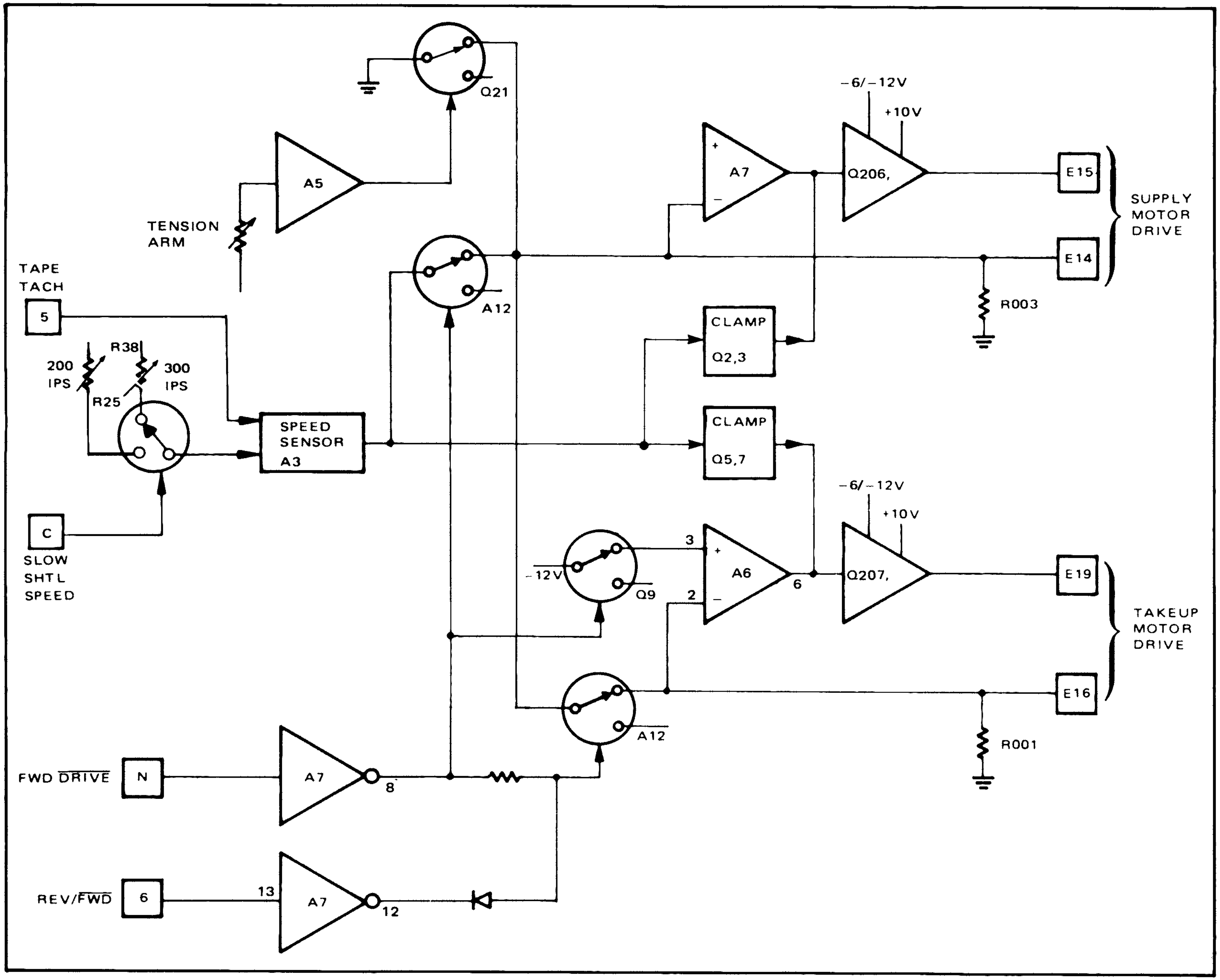


Figure 2-22. Motor Drive Amplifier Fast Forward Mode

motor. This drives the takeup reel motor to a fast forward speed of 300 in/s. Negative-drive current through either the takeup motor or the supply motor causes that reel to take up tape. Positive-drive current (motor current flowing to ground via J5 pins 4/5) causes either of these motors to push out tape. The forward drive signal, from the Search PWA, is pulse width modulated to control the average motor current provided by the MDA assembly.

Initially, as the takeup motor starts, a positive-drive current is sent throught the supply motor, causing it to push out tape. This is done because of initial tape friction and the inertia of the supply reel. Then as the takeup motor picks up speed, this positive-drive current drops off and a low-level negative-drive current is sent through-the supply motor, to provide holdback tape tension.

However, if a reverse/forward from the tachometer (pin 6) inidcates that tape is moving in the rewind direction when the fast forward mode is initiated, switch A12-3 will open. This action prevents the supply reel motor from receiving drive current while the reel is still rotating in the reverse direction. When the tape slows to a stop (momentarily, before commencing forward movement), switch A12 is closed.

As the tape speed increases in the forward direction, current through the takeup motor decreases. Voltage is fed back from a current sense resistor (R001 of the Heat Sink PWA) to operational amplifier A7 via switch A12-3. This causes the current through the supply motor to drop off proportionally. Thus a dynamic holdback tension is affected to maintain a good tape pack.

When the tape speed reaches 300 in/s, (762 cm/s) the takeup motor current is clamped to a lowered value, reducing the takeup torque.

Current to the supply motor is limited to about 1.5A by clamps Q2 and Q3. Clamps Q5, Q7 limit the takeup current to 5A.

2-78. Rewind Mode. Figure 2-23 is a block diagram of the circuitry used during rewind mode. Circuit operation is similar to that described for the fast forward mode. Rewind is initiated when a low rewind drive signal is applied to pin 12. A transistor switch (Q10) is turned off, applying −12 volts to a differential amplifier (A7-3). A current driver (Q004 of the Heat Sink PWA) is then turned on, forcing a negative-drive current through the supply motor causing it to takeup tape. Initially, as the supply motor starts to rewind tape. a positive-drive current is sent through the takeup motor (to overcome inertia and tape friction). Then, when given speed is reached, a low level negative-drive current is sent through the takeup motor, to provide holdback tape tension.

As in fast forward mode, voltage from a current sense resistor (R003 of the Heat Sink PWA) is fed to an operational amplifier (A6-2, via A12-2). This varies the takeup motor current in proportion to the supply motor current, to maintain proper holdback tape tension.

The reverse drive signal from the Search PWA is pulse width modulated to control the average motor current provided by the MDA assembly.

2-79. Record/Play Mode. Figure 2-24 is a block diagram of the MDA circuitry used in the record and play modes. In these modes, the tape speed is determined by the capstan.

During record or play, as the tape is fed off the supply reel the tape between the supply reel and the capstan is mechanically tensioned by a spring-loaded tension arm. The tape is tensioned properly when the tension arm is approximately in the center of its range. A photopotentiometer is linked to the tension arm and produces an error voltage whenever the tension arm deviates from the center of its range.

Tape tension between the takeup reel and the capstan is maintained at about 15 ounces. In order to maintain constant tape tension as the tape pack diameter on the takeup reel increases, the current supplied to the takeup motor must be increased proportionately with the increasing tape pack diameter. This is accomplished by a takeup tension control signal (TU TENSION), produced on the Search PWA takeup reel pack diameter measurement circuitry. This signal is applied through switch A13-2 to an operational amplifier (A6). This amplifier controls a current driver

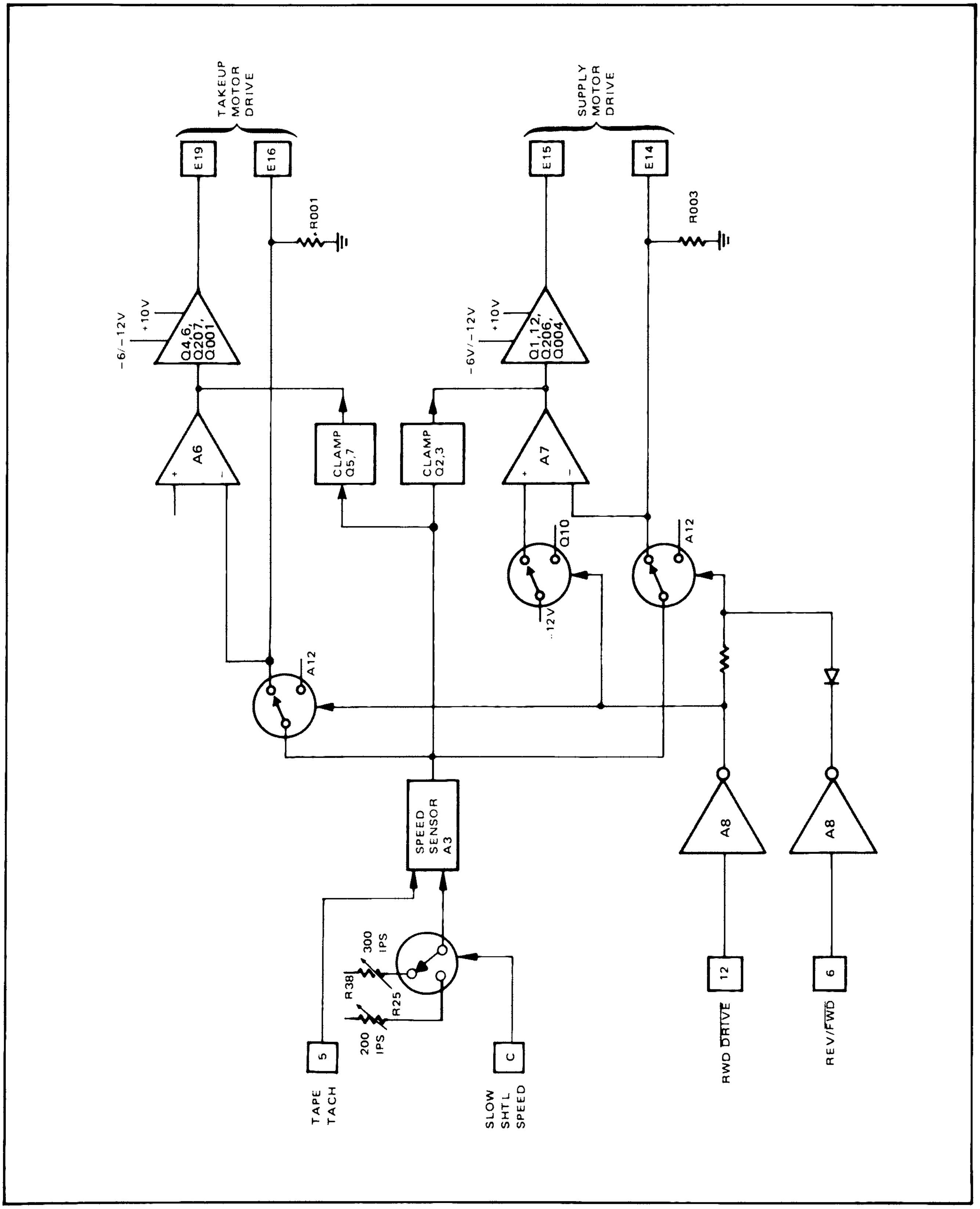


Figure 2-23. Motor Drive Amplifier Rewind Mode

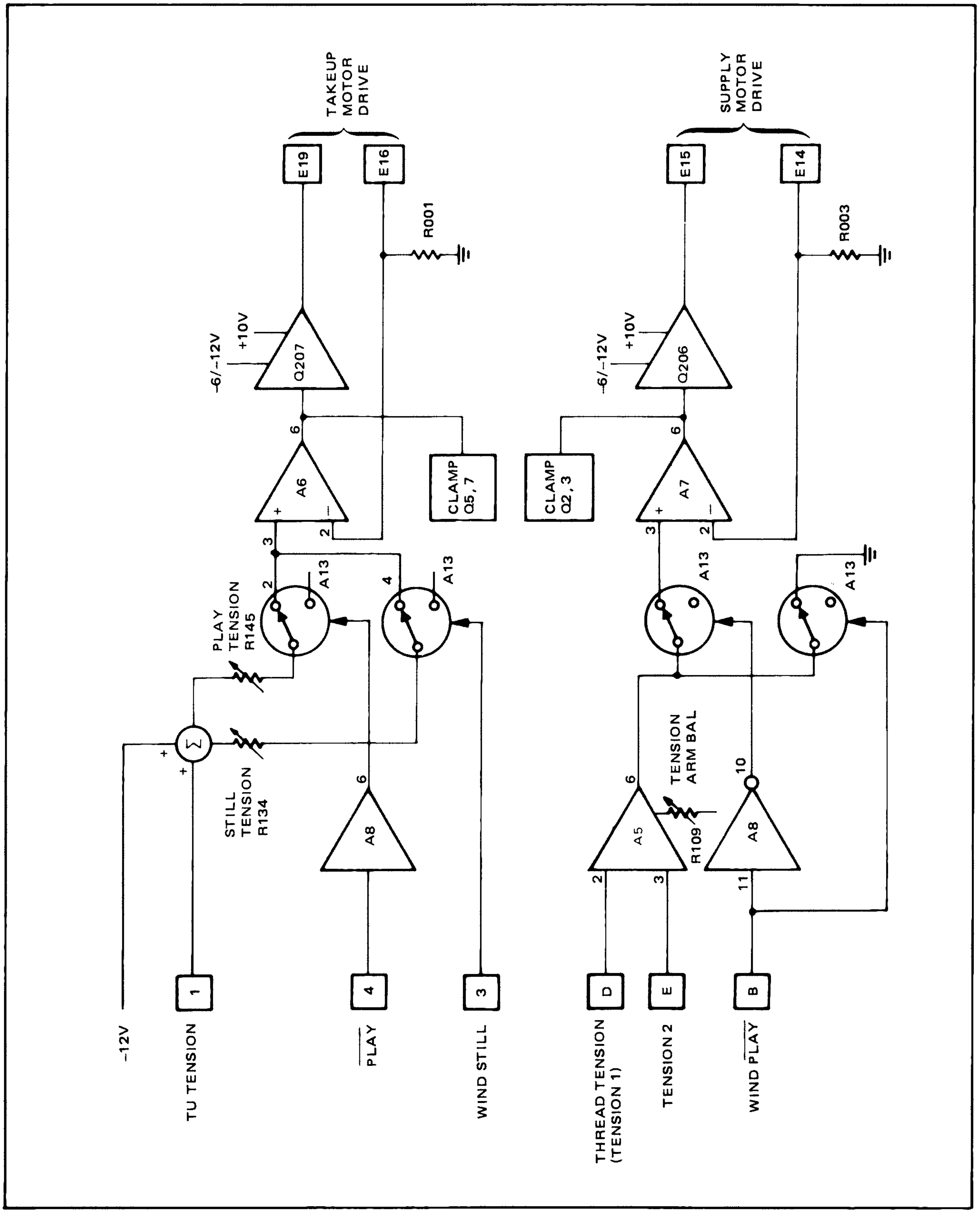


Figure 2-24. Motor Drive Amplifier Record/Play Modes

(Q001 of the heat sink assembly) which drives the takeup reel motor. A potentiometer (R134) is set for the takeup reel motor to produce 15 ounces of tape tension with the takeup reel pack at minimum diameter.

2-80. Forward Crash Mode. Figure 2-25 is a block diagram of the MDA circuitry used during the fast forward crash mode. This mode is entered when two conditions are present simultaneously. First, the reverse/forward signal must indicate that tape is moving in the forward direction. Second, a crash signal, generated by the tape motion circuit on the Search PWA, must be presented to indicate that the tape has run off the supply reel. When these conditions occur together, the tape loaded takeup reel is dynamically braked to a halt.

At the onset of the fast forward crash mode, back emf from the takeup drive motor applies a negative voltage to an operational amplifier (A2-2). If the back emf is more negative than −0.4 volts, this amplifier applies a low to a NOR gate (A9). This gate drives an operational amplifier (A6) to drive current driver Q207. A positive-drive current is sent through the takeup motor, to initiate braking.

The pulse produced by A9-12 is lengthened by the time constant of capacitor C45 and resistor R29. Positive dynamic braking current is driven through the takeup motor for the duration of this pulse. At the end of the pulse, the back emf of the motor is again sensed by operational amplifier A2. If it is still below −0.4 volts, a pulse is again produced at A9-12. This process of pulsing the takeup motor with braking current is continued until the takeup reel is brought to a halt.

2-81. Rewind Crash Mode. Figure 2-26 is a block diagram of the circuitry used during the rewind crash mode. During the course of normal machine operation the rewind crash mode is entered frequently. Thus dynamic braking of the takeup reel lengthens the life of the takeup reel parking brake.

The circuitry that dynamically brakes the tape loaded supply reel is similar to the circuitry that stops the tape loaded takeup reel in the fast forward crash mode, as described in paragraph 2-80. The takeup reel is slowed by a single braking pulse of approximately one second duration, initiated by a one shot (A3). A low crash signal (pin A) triggers the one shot, the output of which is applied to a NOR gate (A9). As the reverse/forward signal is high in rewind, this NOR gate is high for the duration of the one shot pulse. This drives an amplifier (A6), producing a negative-drive current that slows down the takeup motor. If the takeup motor is over-torqued and begins to rotate in the opposite direction, it will be brought to a stop by the fast forward crash mode braking circuitry.

2-82. *Reverse Slow Motion Mode.* When the reverse slow motion mode is activated, the circuitry of the reverse slow motion piggyback PWA becomes effective. This circuitry and its interface to the MDA are shown in Figure 2-27.

When the VTR enters reverse slow motion play, the functions of the supply and takeup reels reverse, and tensions must be altered accordingly. The FWD/REV CMD command serves to switch the reference input of amplifier A1-14 through the diode. With the altered reference input, A1-14 supplies a voltage to the takeup motor drive amp circuitry to produce less tension.

The reverse TU tension poteniometer provides for holdback tension adjustment. When the FWD/REF CMD command is in reverse state, it opens switches A8-4 and A8-8. Switch A8-4 open changes the bias of takeup clamp Q5, Q7 and supply clamp Q2, Q3. This allows the supply motor to provide increased takeup tension for reverse. Switch A8-8 open places the operation of damping amplifier A10-8 under control of switch A9-4 and REV/FWD CMD command (pin 6).

2-83. Forward-to-Reverse Tension Damping Circuit. The supply tape tension — which is normally about 4-1/2 ounces at the scanner input during forward play, must be increased to about 8 ounces during reverse slow-motion play. The rapid increase in tension which occurs during the forward to slow reverse transition must be damped to prevent oscillation of the supply motor and its tension servo circuitry. Damping is accomplished in the following manner: During forward play, the voltage developed across resistor R003 (in series with supply motor return, on heat sink assembly)

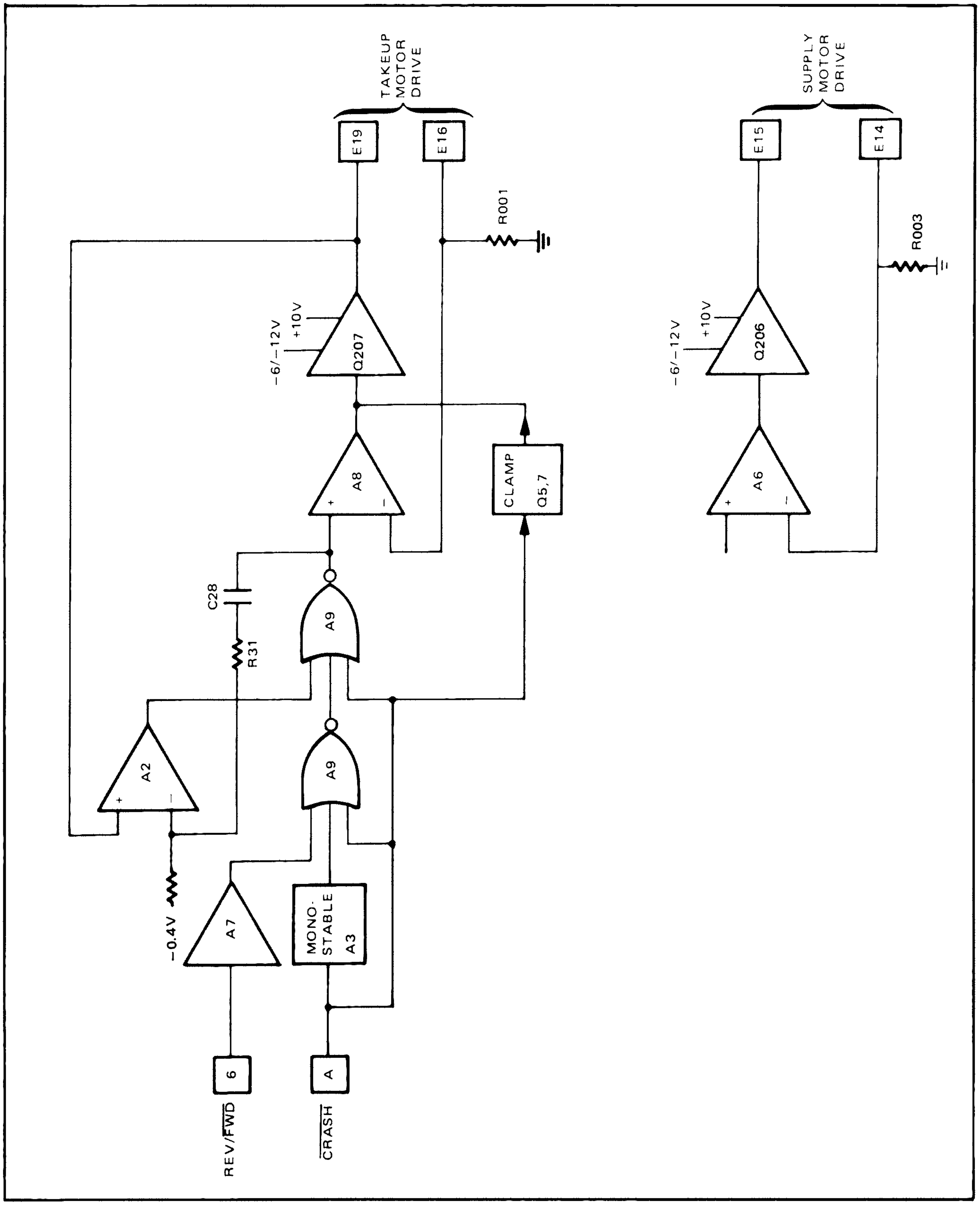


Figure 2-25. Motor Drive Amplifier Fast Forward Crash Mode

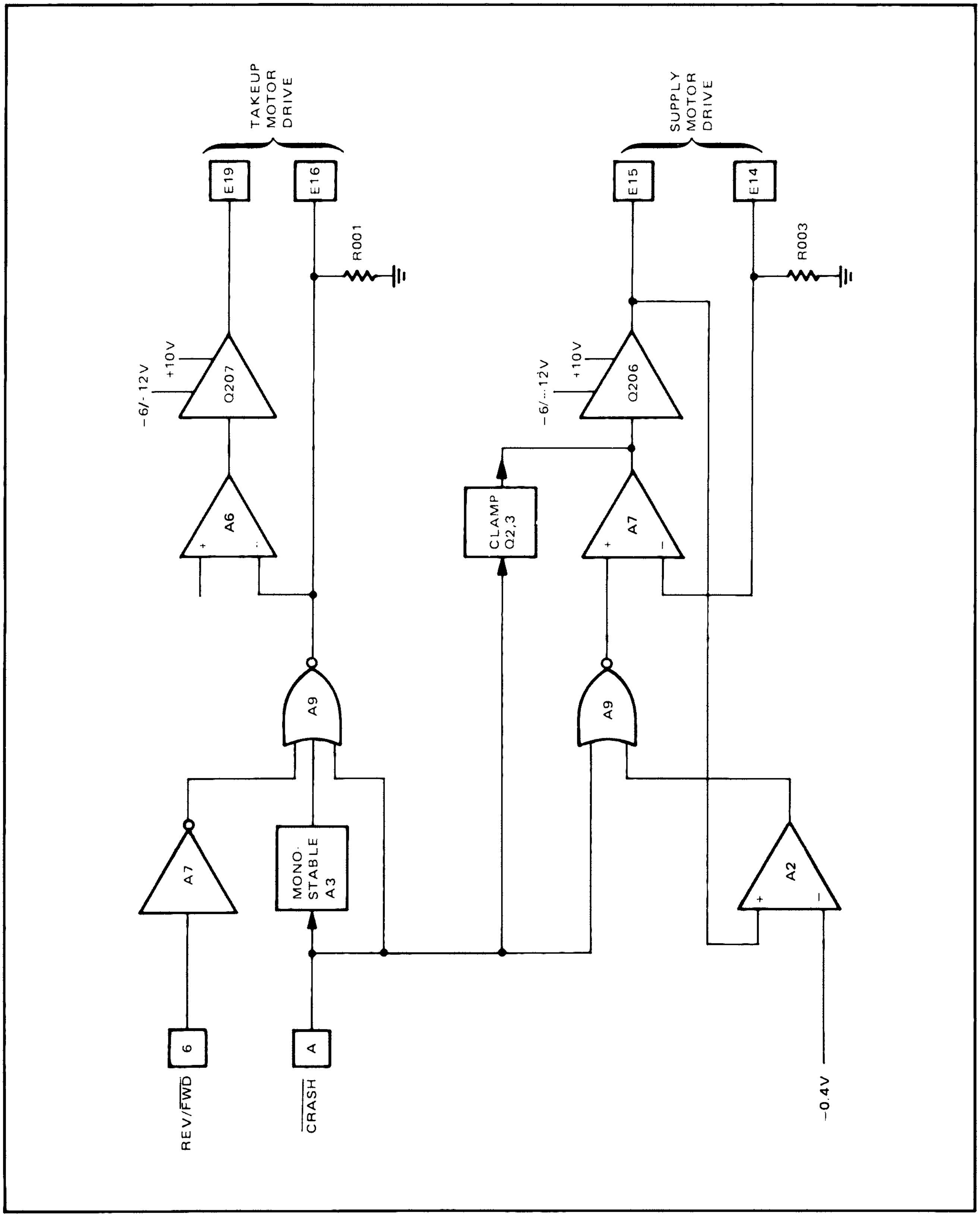


Figure 2-26. Motor Drive Amplifier Rewind Crash Mode

is buffered by amplifier A10-1 and supplied to the supply motor forward current sample capacitor, C10. This voltage sample accurately represents supply tape pack size, since motor current required to maintain tape tension is proportional to tape pack size. When the VTR transition from forward to reverse occurs, switch A9-4 switches, grounding one side of C10. The other side of C10 goes to the input of amplifier A10-8. The instantaneous voltage present at this amplifier's input causes its output to supply approximate final value drive to the input to amplifier A6 via steering diode CR12. This signal effectively overrides any oscillatory signal coming form the summing point. This overriding signal endures for a fixed time constant (about 1/2 second) until the supply motor stabilizes at the increased torque level. When C10 charges up sufficiently in the reverse direction, steering diode CR12 is back biased – effectively isolating the damping circuit from any further interaction with the supply motor tension servo circuit.

The degree of damping is calibrated by the FWD/REV damping potentiometer, and the offset is controlled by the REV/STOP offset potentiometer (part of offset circuit). The reverse tension amplifier Q1 supplies increased current to the supply motor in reverse motion. This current value is scaled to the size of the supply tape pack to keep the tension increase constant. An analog signal representing supply pack size is provided by the frequency comparator circuit. This circuit is exactly the same as the frequency comparator circuit of the Search PWA which provides the pack size function for the takeup reel.

The tape tach signal is divided by two, ripples through a counter, and is converted to an analog value by a D/A amplifier. The circuit is reset by the once-around signal from the supply reel tachometer. Thus, the analog signal amplitude results directly from the number of tach pulses-per-reset (once-around) pulse. The greater the number of tach pulses per once-around pulse the larger the supply reel pack, and greater the supply reel tension supplied. The resulting tension signal is summed with the tension arm signal to drive amplifier A5. During stop mode, a fixed tension value is substituted at the input to reverse tension amplifier Q1 by switch A9-14 (STOP position). Several potentiometers are provided for calibration of the reverse tension amplifier circuit.

2-84. Capstan Drive Circuit. The analog capstan drive signal (pin P) from the Capstan Servo PWA is amplified (A10) and then applied to current driver circuitry on the MDA Driver PWA. The output of this circuit goes to driver circuitry (Q002, 003) on the Heat Sink PWA. The output and return lines from this PWA are then applied to current drivers (Q208, Q209, Q210 and Q211) on the MDA Driver PWA. These drivers are switched by the capstan reverse command (pin 13) to cause either forward or reverse capstan motor drive.

2-85. Scanner Drive Circuit. The scanner error drive signal from the Scanner Servo PWA is applied to an amplifier A11-6 in the MDA Electronics PWA. This drives a transitor amplifier (Q005, 006) in the Heat Sink PWA, which provides drive current for the scanner motor.

A scanner off signal from the Scanner Servo PWA is amplified in the MDA Electronics PWA to turn on a current Q201 in the MDA Driver PWA. This shunts the scanner drive current to ground, through a 0.2 ohm resistor (R004) located on the Heat Sink PWA.

Rapid slowdown, like that required for scanner phasing originates with transistor Q24. During negative scanner error drive, Q24 conducts less, allowing pullup resistor R110 to forward bias current Q201. Q201 (in turn) shunts a portion of scanner drive current to ground, including current produced by the motor itself while acting as an inertia driven generator.

2-86. SERVO CIRCUIT DESCRIPTION

2-87. General

The servo system consists of up to nine PWA's comprising various servo systems. These PWA's are shown in the Servo System Block Diagram Figure 2-28. The servos are: the scanner servo, the capstan servo, and the optional automatic scan tracking (AST) servo. The AST servo interacts with the other servos during normal or

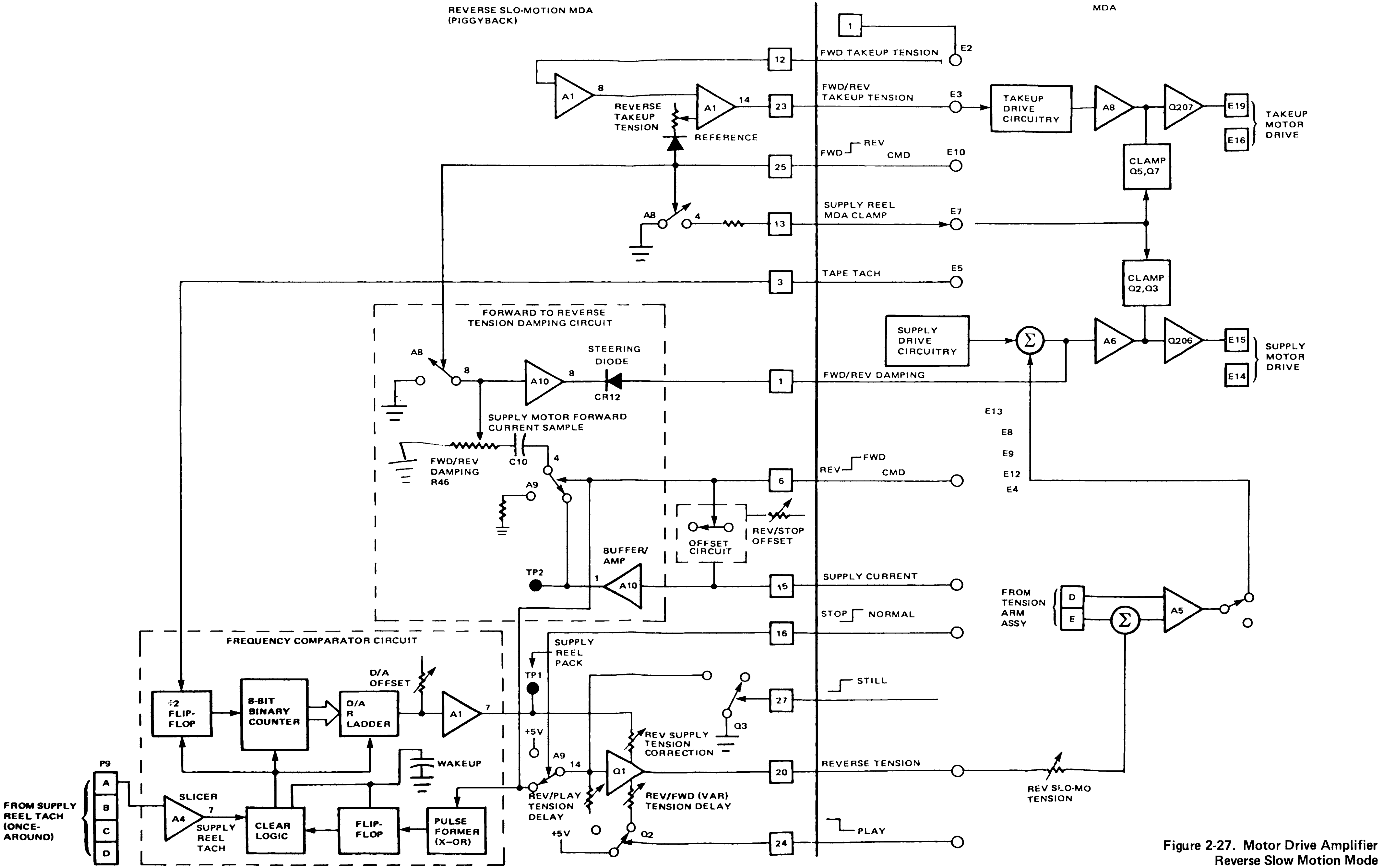


Figure 2-27. Motor Drive Amplifier Reverse Slow Motion Mode

or slow/still play modes. The scanner servo and capstan servo function during record and edit record modes to produce recordings which conform rigidly to Type C format specifications. In playback mode, all servos work together to provide picture material and sound that (when time base corrected) is of studio production quality.

2-88. Scanner Servo Loop. The scanner servo drives the scanner motor (via the MDA) controlling its speed and phase during all modes of operation. The scanner rotates at a field rate. This permits it to record or play one video track per field – at the standard rate of 60 (or 50 Hz) hertz. Further, it maintains proper head phase (with respect to the track) such that dropout occurs during the vertical interval.

2-89. Capstan Servo Loop. This servo drives the capstan motor which controls tape speed on the transport. In record mode, the capstan servo causes tape speed to be precisely that specified by the Type C Formta. In additon, this servo system generates, from the video signal, the control track record waveform. In playback mode, the capstan servo system establishes a timing relationship between playback control track and reference timing.

2-90. AST Servo Loop. This servo loop controls transverse position of the AST playback head. The system senses tracking errors by detecting variations in the reproduced rf envelope. The results of this feedback are used to alter the position of the video reproduce head – causing it to follow the center of the video track.

In slow motion and still frame modes, the head is caused to deflect – thereby compensating for tape speed induced and geometric tracking errors. In record mode, the AST servo tracks the recorded video – providing video confidence.

2-91. System Interaction. There is minimal interaction among servo loops when machine or tape errors are small. The systems do interact when errors are too great for a given system to correct, or when there is a change in mode. During playback, the scanner and capstan servos are referenced to station sync. During record, the capstan and scanner servo loops are referenced to the video signal being recorded, and the AST loop operates independently to follow the record track. During insert edits, the capstan servo is referenced by the control track in both edit play and edit record. During an assembly edit, the capstan servo is referenced by control track during edit play, and by capstan tach during edit record.

2-92. AST Servo PWA No. 9

The automatic scan tracking (AST) system consists of a positionable reproduce video head controlled by a closed loop electronic servo system. The AST head assembly consists of a ferrite head mounted on a cantilevered piezo-ceramic flexure element. The head can be electronically deflected 0.5 mm or ± 1 video track.

The AST Servo PWA provides the main control circuits for the AST servo. This servo keeps the head on track in playback modes of normal speed, still mode, continuously variable forward and reverse slow motion, and forward speeds beyond X1. The AST Servo PWA operates in conjunction with the AST Filter PWA and the AST Driver PWA.

Refer to the simplified block diagram of the AST servo loop, Figure 2-29. This shows the relationship of the AST Servo PWA to the other PWA's in the AST servo . The AST playback head assembly is vibrated, transversely to the tape track, at 450 Hz or 425 Hz. This amplitude – modulates the playback rf to provide tracking error information. The playback rf is amplified to the Preamplifier PWA, the Equalizer PWA, then to the AST Servo PWA. Tracking error detection is accomplished by envelope detection and then synchronous detection at the dither frequency, 450 Hz (525 line) or 425 Hz (625 line). The error signal is passed through a low pass filter to provide a dc error component, which is then applied to the AST head through reset logic and error integration circuitry. The low-pass filter output includes ac (dynamic tracking) error components. This output is routed through a comb filter to provide an ac correction signal. The ac and dc correction signals are summed with the dither frequency and with a mechanical damping component. The resulting servo correction signal is applied to the AST Driver PWA. This PWA provides drive to the flexure element

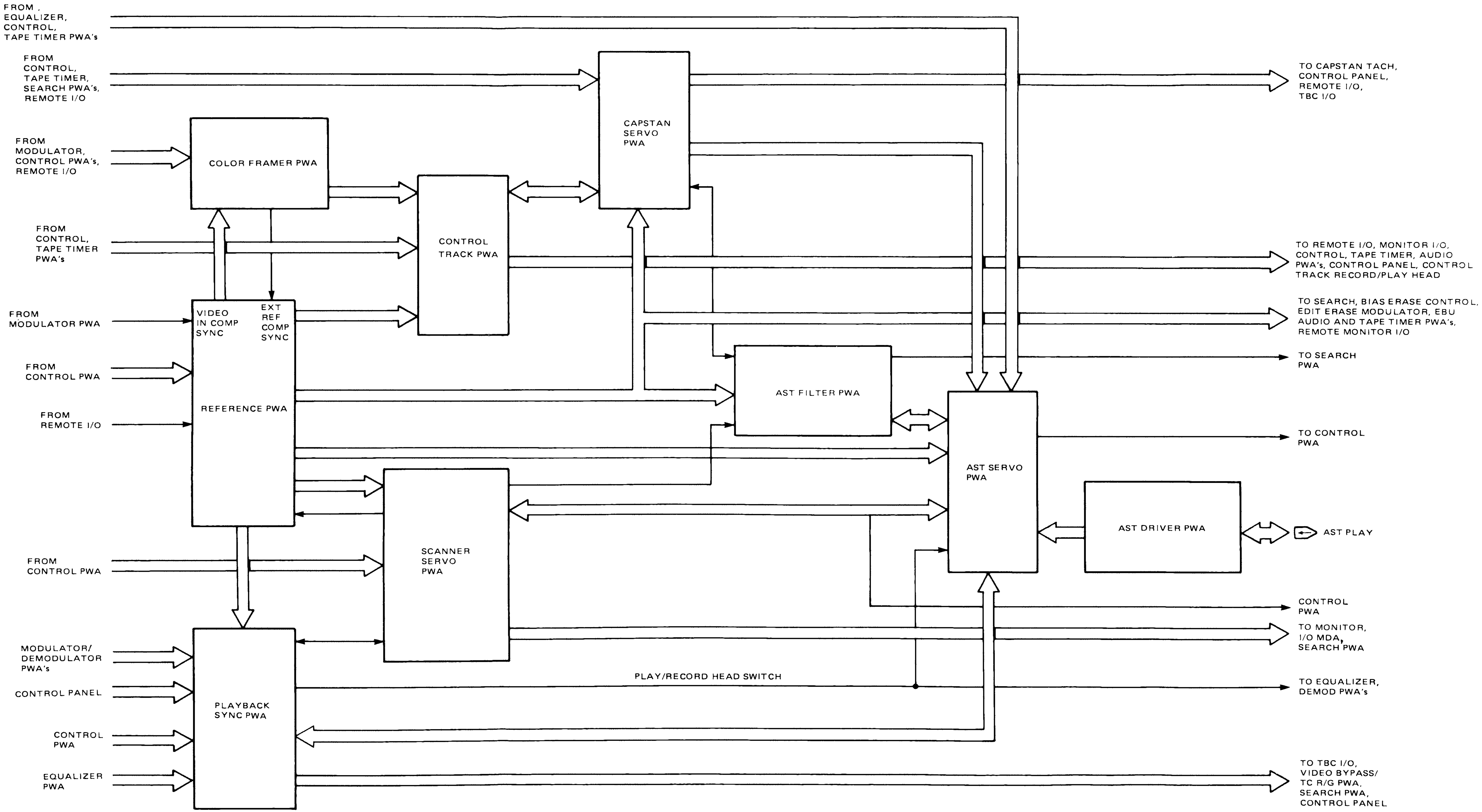


Figure 2-28. Servo System

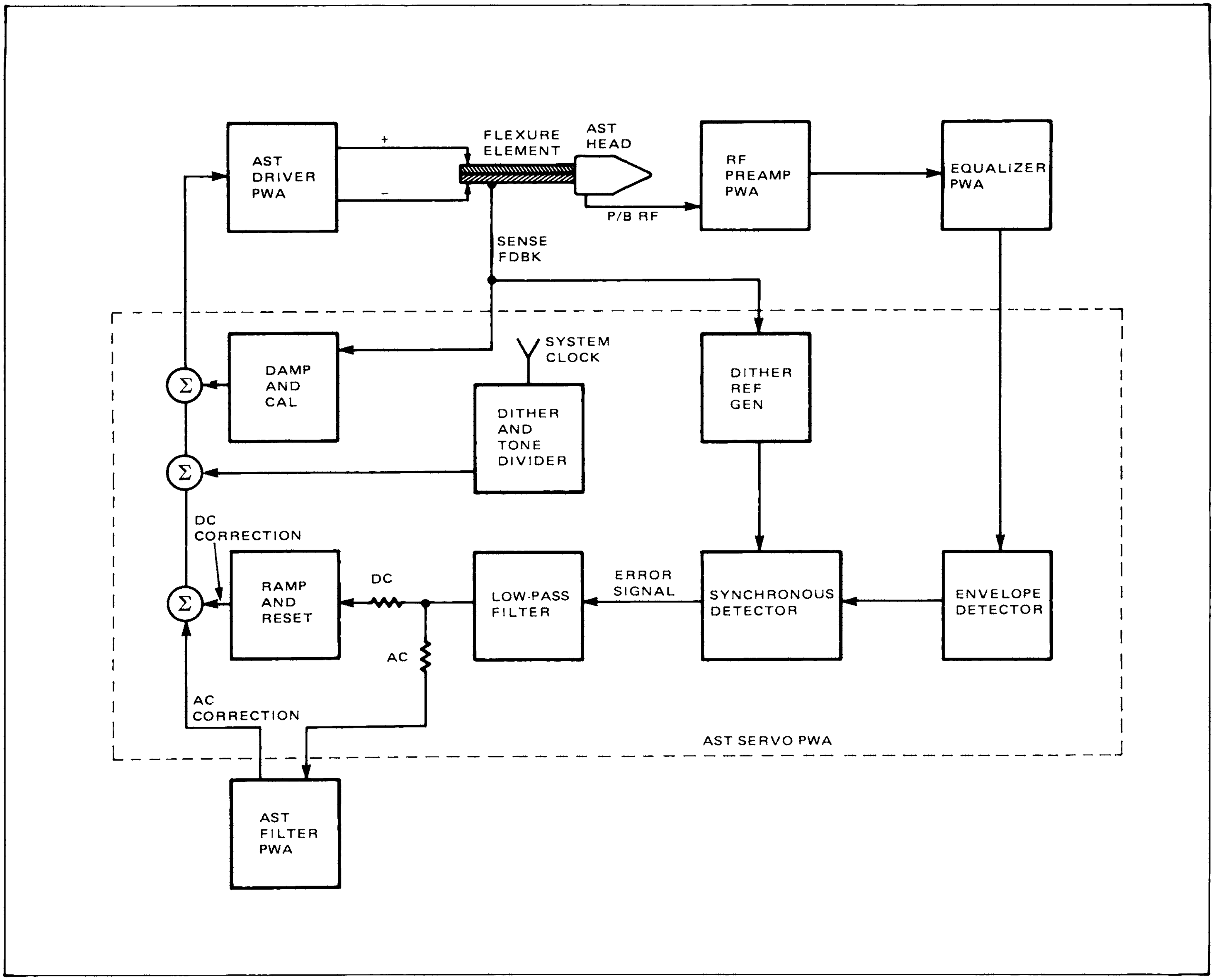


Figure 2-29. Simplified Block Diagram of AST Servo Loop

to correct the head position and to maintain the dither frequency vibration. A sense strip on the flexure element provides a velocity signal for the AST Driver PWA, for electronically damping the flexure elements mechanical resonance. Paragraphs 2-93 and 2-94 provide background information on some basic AST concepts. Paragraphs 2-94 through 2-100 describe the various circuit functions of the AST Servo PWA.

2-93. Error Detection. A decrease in the rf envelope indicates the head is off track, without indicating the direction of the error. Sinusoidally vibrating the head across the track, at dither frequency, provides direction information. Refer to **Figure 2-30, which shows the basic dc error detection method for AST tracking errors.** With the head on track, the dither signal deflects it off track an equal amount in both directions, and the detected rf envelope is the same for each half cycle of dither frequency. This signal is then synchronously detected at dither frequency; the polarities of alternate half cycles are reversed, synchronously with polarity changes in the dither signal. The resulting error waveform is passed through a low-pass filter to eliminate the dither component and provide an average dc error value (in this case, zero). With the head to the right of the track, it will be deflected for a greater average error to the right side, than to the left, resulting in a filtered dc error component. With the head to the left of the track, the deflections will cause an average dc error of opposite polarity.

The low pass filter output includes ac error components at reduced levels. The output is passed through a comb filter, which is in parallel with the ramp and reset circuit. The comb filter, located on the AST Filter PWA, provides response at three specific frequencies: 60, 120 and 180 Hz (525 line), or 50, 100 and 150 Hz (625 line). This is designed, in particular, for correcting dynamic tracking errors associated with tape interchange. These errors repeat each scanner revolution, so appear at a fundamental frequency of the scanner revolution rate, and its harmonics. The comb filter, by passing only these specific frequencies, provides an improved signal to noise ratio, and does so employing a relatively narrow equivalent bandwidth for following ac errors.

2-94. Slow Motion/Still Mode. Figure 2-31a shows the head to tape geometry considerations for still mode operation. F1, F2 and F3 denote recorded field tracks. The dotted line is the path of the scanning head, in the direction indicated, with tape stopped and AST system disabled. During normal speed forward play, the tape moves at a velocity that keeps track F2 coincident with the dotted line scanning path. In still mode the head must be moved toward F2 at the rate of one track-to-track distance per scan, to stay on track. When the head reaches the end of the F2 track, it must be reset to its original position before starting the next scan of F2. This is done during the vertical interval dropout.

Figure 2-31b shows the head deflection (opposite to tape direction) for keeping the head on the F2 track in still mode operation. The sawtooth drive signal for this deflection is generated in the ramp and reset circuit. At the end of each field scan of F2 the head must be reset by one track or it would start the next scan at the F3 track.

Figure 2-31c shows the head deflection for 1/5 speed slow motion. The slope of the deflection is only 80% of that for still mode operation, as the track moves 0.2 of a track-to-track distance, per scan. However, a reset deflection is always a full track-to-track distance. Therefore the deflection path gradually moves upward (direction of tape movement). Finally, the F2 track has moved as far as the head deflector is able to track it. A level detector in the reset logic circuit checks about 1 millisecond before the end of each track scan, to see if the correction voltage is greater than zero. When it is, a reset pulse is inhibited, and the head moves on to scan F3.

Figure 2-31d shows head deflection during reverse slow motion. The deflection slope is greater than that for stil mode, by the amount of tape movement per scan. However, the reset deflections are just one track-to-track distance. Therefore the deflection path gradually moves down (reverse tape direction). The reverse motion level detector senses, 1 millisecond before the end of each scan, whether the minus one track limit is exceeded. If it is, a double amplitude reset pulse is provided, to move the head to the preceding track, F1.

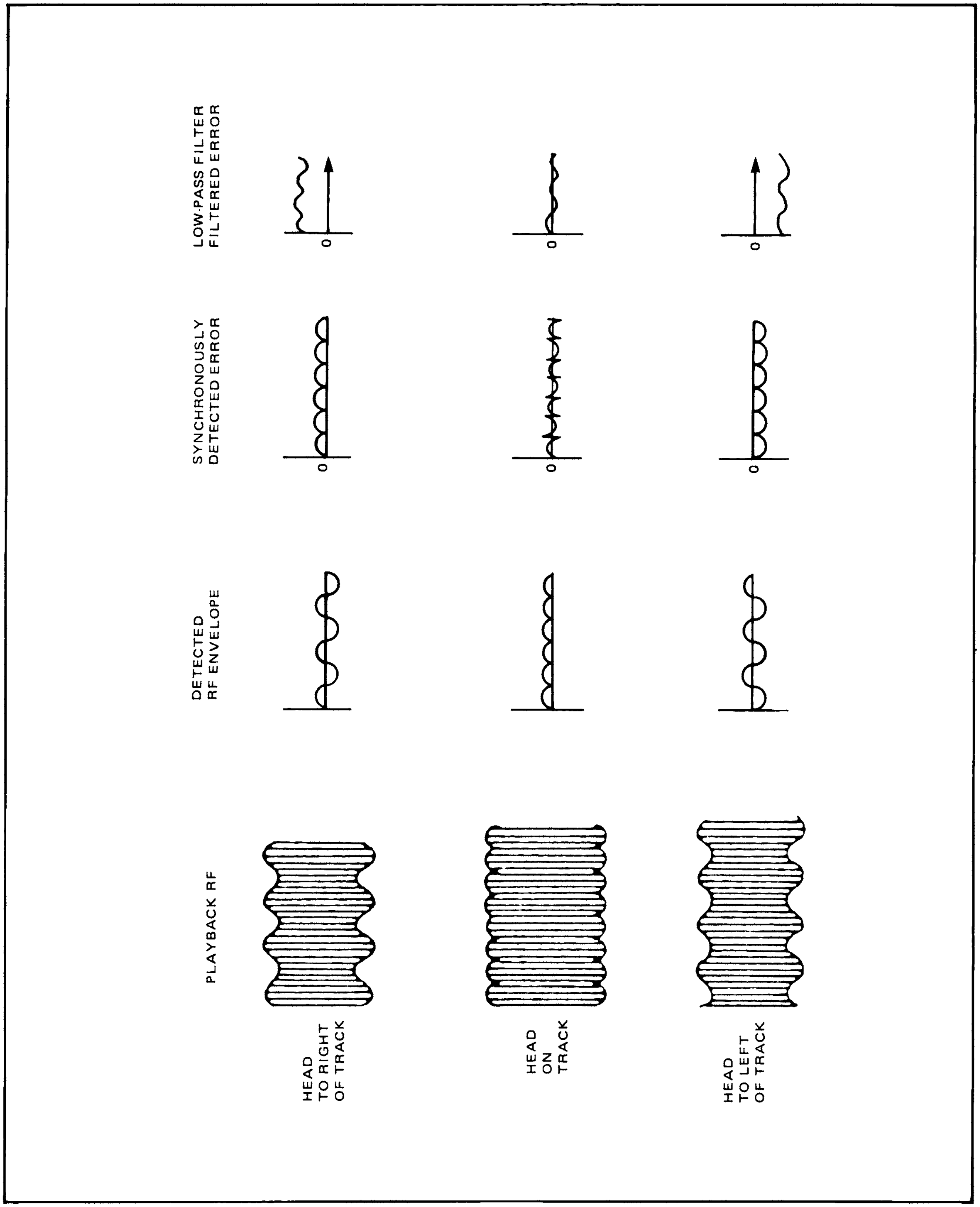


Figure 2-30. DC Error Detection

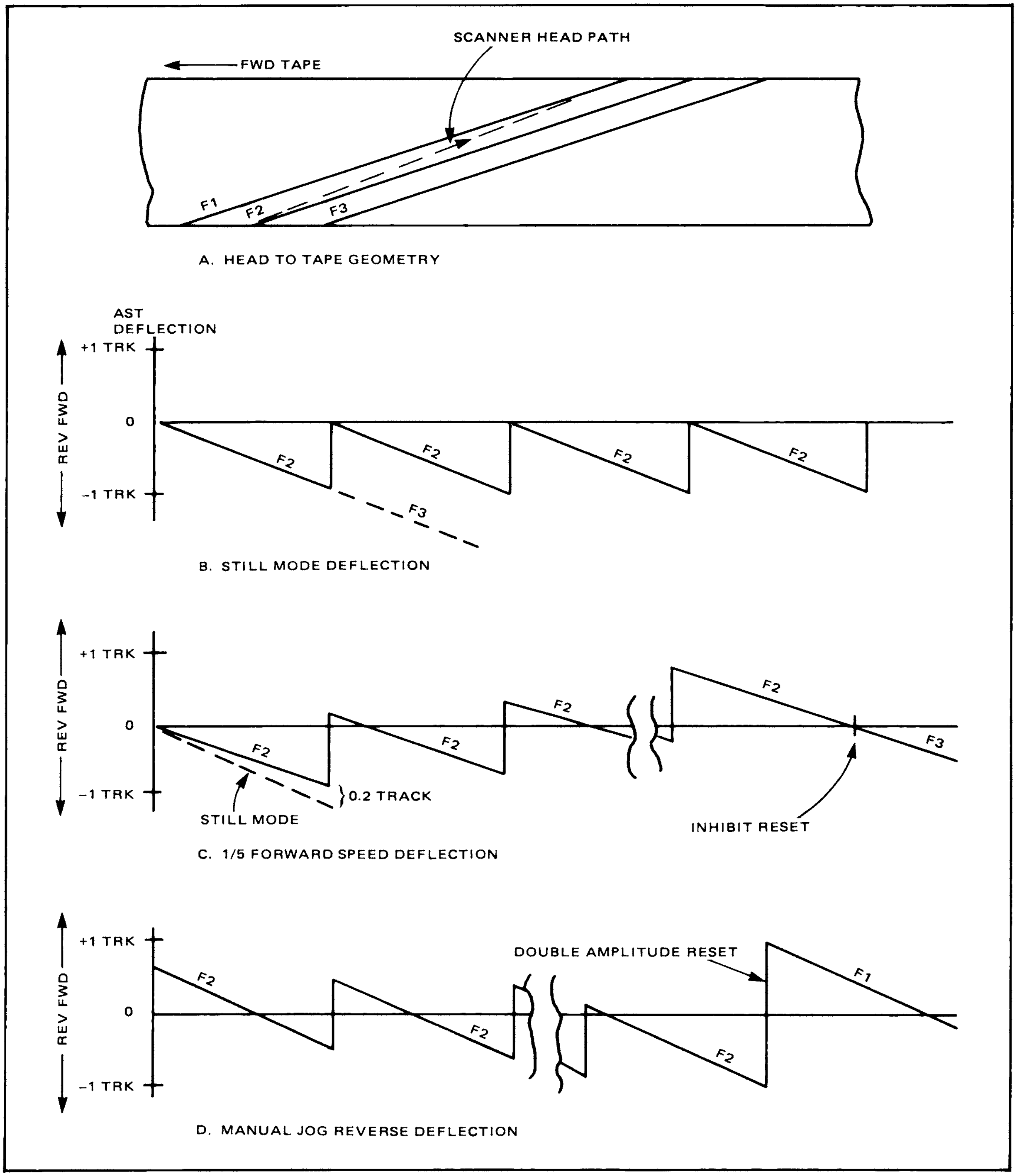


Figure 2-31. Slow Motion/Still Mode

For forward speeds greater than X 1, deflection slope in the forward direction is needed. For a X 1.1 speed, for example, the slope will be gradual and about 10 tracks will be scanned before the head deflection limit is reached. A separate level detector senses when the plus one track limit is reached, and initiates a one track reset in the opposite direction.

2-95. AGC and Envelope Detector. Refer to the AST servo schematic diagram, 1400095, and to the block diagram, Figure 2-32. The AST rf signal is applied to a dc controlled input amplifier (A45-8) which drives an envelope detector (A44). An AGC feedback loop applies the detected output through an amplifier (A39-7) to the AGC pin of the input amplifier. This feedback path is closed during normal scanning and is switched open during dropout. Otherwise, a loop transient would occur as the envelope detector tried to follow the dropout pulse. Timing for the dropout pulse is provided by the drum tach pulses via a one shot. The use of an AGC loop eliminates a servo loop gain adjustment and dc output variations due to detector I.C. differences.

During normal scanning the AGC loop maintains a +2V level (C55/R75 junction), as a +2V reference is applied to an amplifier (A39-7) in the feedback path. This level is clamped by a switch to +5V during dropout. As seen at TP8, the rf detected output is servoed to a 3V ac change in the AGC system. The amplifier (A43-7) fed by the envelope detector is bypassed by a switch during dropout. This prevents the large dropout transition from being applied to the synchronous detector.

2-96. 175-Hz High-pass Filter. Referring to Figure 2-32, the dropout clamp feeds a high-pass filter circuit. This filter is switched in by the auto-track delay signal form the AST Filter PWA, after the tape is in control track lock. This is done to filter out low frequency variations that may occur during acquisition, to prevent large-amplitude spurious components from overdriving the synchronous detector. The rest of the time this filter is switched out.

2-97. Dither Reference Generator. This circuit provides dither frequency switching for the synchronous detector. It does this by selectively filtering and squaring the dither frequency components present on the AST sense strip preamp. The circuit inputs are ref 2H, from the Reference PWA, the dither input reference clock signal from the AST Filter PWA, and the output of the flexure element sense strip preamp. The ref 2H pulses are counted in a counter which is cleared at the dither rate. The counter outputs are decoded to provide ten sequential low outputs per dither period. These outputs sequentially connect capacitors (C42-C51) to ground, causing sampling of the sense amp signal.

At normal speeds, the sense amp composite signal will essentially contain only the dither frequency. However, the dither frequency will be super-imposed on a sawtooth for still mode, slow motion, or above normal speeds. The capacitors are sequentially pulsed to provide a sampling of the waveform, at ten samples per cycle. Any sawtooth or non-dither frequency component is removed and the waveform is synchronized with the dither reference (dither in) signal. No phase shift is introduced, since the filter center frequency is clock controlled by the dither in reference signal. The resulting synchronous detector switching is locked and phased to the dither in reference clock signal.

The sampled waveform is buffered and applied to low pass filter circuitry to eliminate the sampling steps from the waveform. A slight phase shift is introduced by the filtering but is compensated for by a capacitor (C57). The output is squared and applied to the synchronous detector.

2-98. Synchronous Detector/LPF. The envelope detector output is applied (via a high pass filter during acquisition mode) to the synchronous detector. This circuit (A43-1, 14) provides non-inverted and inverted signals to switches. These switches are alternately activated by the dither reference square wave, inverting alternate half cycles of the envelope detected signal. Refer to Figure 2-30, DC Error Detection. The Detected RF Envelope column shows the waveforms applied to this circuit. The Synchronously Detected Error column shows the output of this circuit, which is applied to low pass filter circuitry (A42-14). This filter provides the resultant dc error signal, which goes to the ramp and reset circuit. The ac error signal is applied to the comb filter, on the AST Filter PWA.

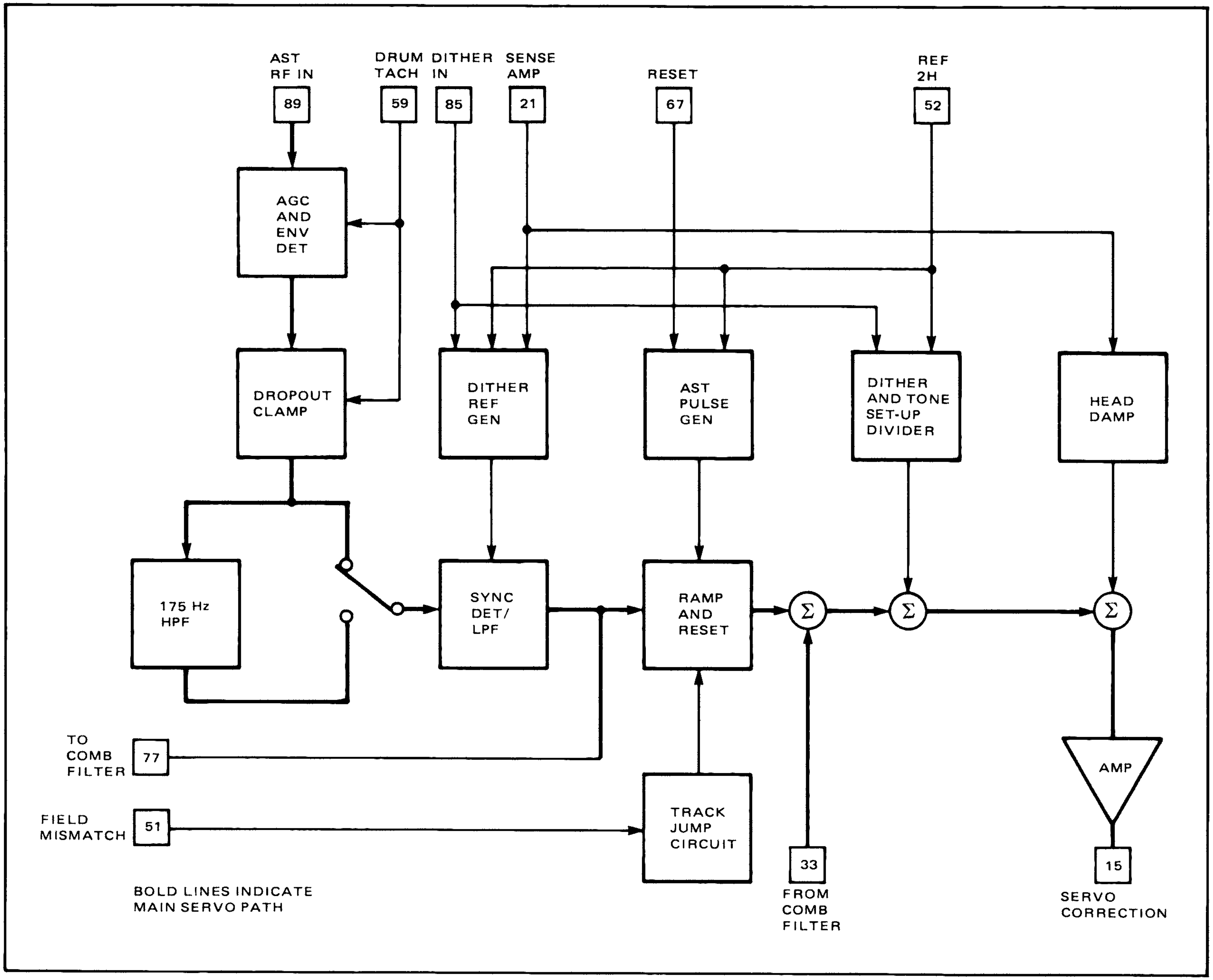


Figure 2-32. AST Servo PWA Block Diagram

2-99. AST Pulse Generator. This circuit provides enabling pulses to the ramp and reset circuit. These pulses are timed so that head jumps will occur during dropout. The 2H signal is counted (A2-5) 15 counts of 2H allowing a pulse width of 512 micro seconds A3-8, 9). Both flip-flops are then cleared by the carry output (A2-12). The reset pulse, pins 67/68, clocks the circuit (A3-3) to enable counting at a time determined by a phase adjustment potentiometer (R3).

2-100. Ramp and Reset Circuit. Refer to the simplified block diagram of this circuit, Figure 2-33. The dc error signal is applied to the main integrator, consisting of an op amp (A35-8) using a controllable feedback configuration in additon to a large capacitive feedback. This integrator generates the slope for variable slow motion, and generates the dc correction signal for normal play. Its output is applied to three level detectors consisting of op amps with some positive feedback for hysteresis.

One of these level detectors (A26-7), operating in the variable forward mode, compares this signal to a variable reference that depends on the tach input signal. A second op amp (A35-1), operating in the reverse tape mode, compares the error signal to +3.35V. The third op amp (A35-14) operates in the X2 mode, and compares the error signal to −3.25V.

When the integrator output reaches a level requiring the head to be reset, the appropriate level detector is activated. The output, translated to TTL, is clocked into a latch by the reset pulse (pins 67/68). The latch output is gated by a 512-microsecond reset pulse from the AST pulse generator. The gate outputs are summed in an analog manner and applied to the main integrator, causing a reset pulse in the servo correction signal. A calibration potentiometer (R98) is set for exactly a 3.0-volt output from the integrator, corresponding to a one-track change.

Half speed sensing, based on tape tach information controls the main integrator feedback configuration, via a switch (A36-1, 2). This switch is opened at speeds above one-half, enabling feedback circuitry to provide a wider operating range for the main integrator. At speeds below one half the switch closes, shunting part of the feedback loop, to narrow the operating range as determined by a diode/capacitor configuration.

2-101. Miscellaneous Circuits. The dither and tone divider circuit provides either a 450 Hz (425 Hz) square wave, or a 750 Hz tone, as selected by jumper J1. With J1 at the operate position, the dither input signal (pins 85/86) is routed through a low-pass filter (A42-1, 7) and summed with the servo correction signal. The saw and sine positions of J1 are used for AST servo setup purposes, providing a 750-Hz sine wave output, and a ramp output, for the AST servo correction signal.

Field mismatch sensing circuit A6 and associated circuitry monitor the incoming logic level on FIELD MISMATCH PIN 51. When a mismatch is detected, (wrong track condition) a track jump pulse is generated at A7-6. Simultaneously, lockout circuit A6A prohibits A6B from responding to incoming pulses until 4 fields have elapsed. This provides noise immunity before another jump is allowed.

The damping and calibrate circuit is adjusted to electronically dampen the mechanical resonance of the AST flexure element. The circuit uses negative feedback from the AST sense strip. The sense amplifier signal (pins 21/22) enters the circuit at TP4. The needed phase shifts and attenuation are provided by a series of compensating networks (A40-7, 14, 8 and A34-7). Adjustments are provided for null frequency, damping phase, and damping gain. The circuit provides a correction component, at the board output, of the AST servo correction signal.

2-102. AST Filter PWA No. 10

This PWA provides functions within the AST servo system, including ac/dc gate generation, dither frequency division, head jump triggering, and comb filtering. Refer to Schematic Diagram 1400102 and the block diagram of Figure 2-34. The following circuit descriptions refer to both 525 and 625 line use, except as noted.

2-103. Dither Frequency Divider. The dither frequency divider circuit (A13, A19) divides the 64H clock signal, from the Reference PWA. It provides

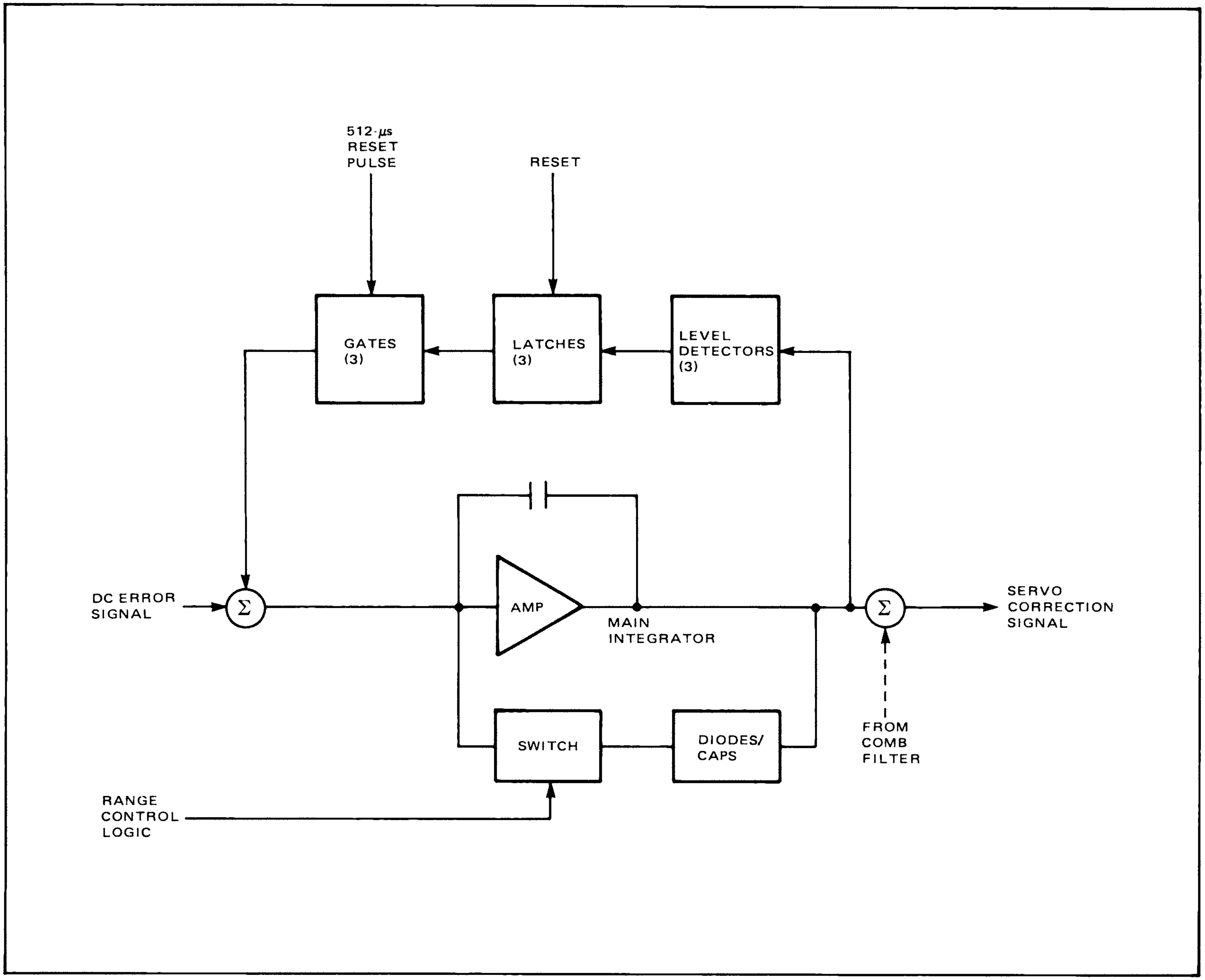


Figure 2-33. Ramp and Reset Circuit Simplified Block Diagram

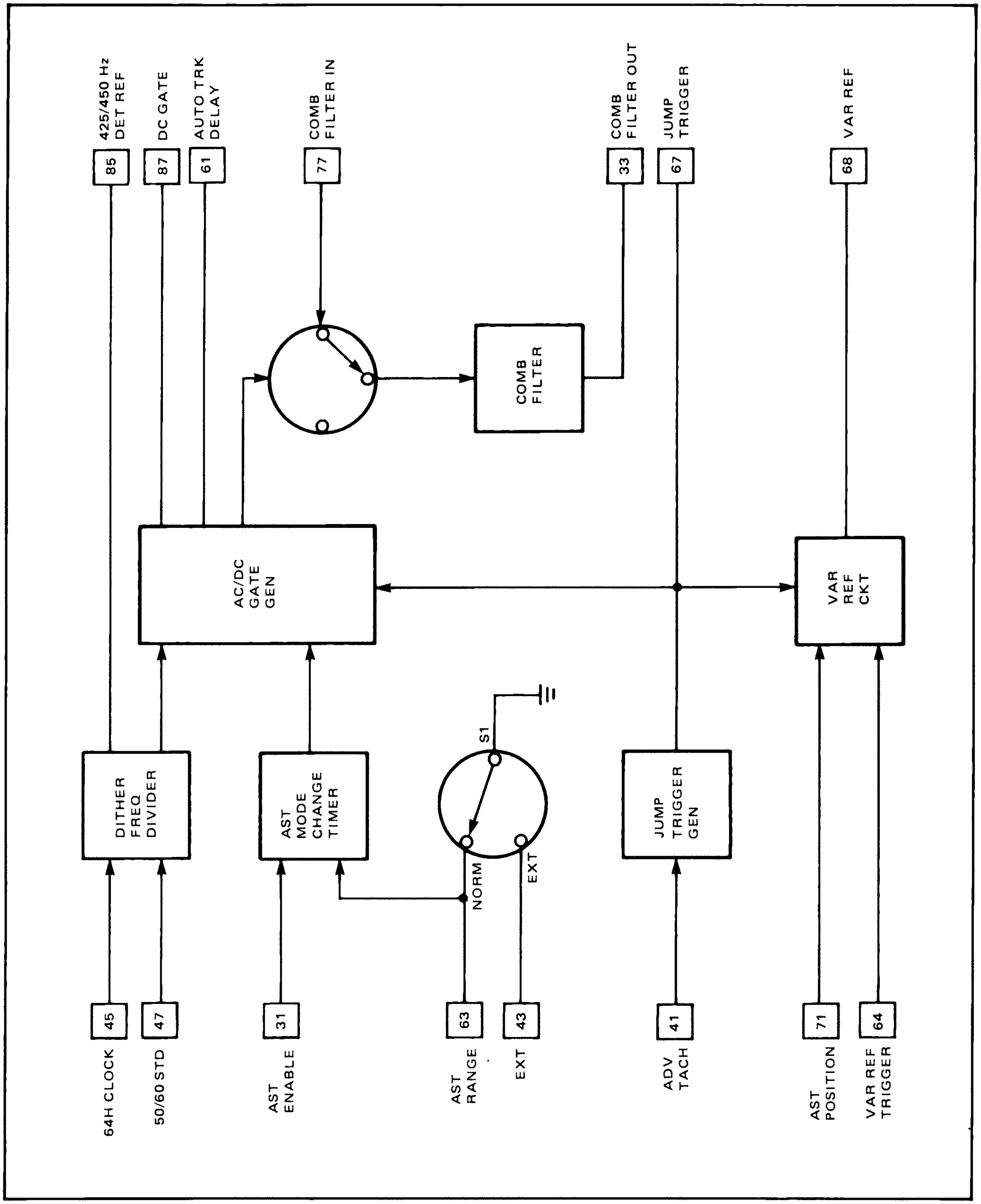


Figure 2-34. AST Filter PWA Block Diagram

a 425/625-Hz signal for line use, as determined by the 50/60 standard signal. The 425/450 Hz detector reference output is sent to the AST Servo PWA, for use by the synchronous detector and the dither generator.

2-104. Ac/Dc Gate Generation. This circuit (A9, A10, A15) receives inputs from the 64H divider, the jump trigger generator, and the AST mode change timer. The outputs generated are the ac and dc gate pulses for switching the AST servo error circuits in and out of the servo loop at the proper times.

The dc gate pulse (A14) is timed to occur approximately in the middle of the field scan. This four millisecond pulse is used for sampling the dc servo error, on the AST Servo PWA. The ac gate pulse (A2, A3) is used for sampling the comb filter input signal. It starts at the center of the scan also, but the pulse width is increased slowly until the entire scan is being sampled. A carry output (A10-12) from this circuit is used to provide the auto track delay signal, for the AST Servo PWA.

2-105. Comb Filter. The servo signal from the synchronous detector of the AST Servo PWA is applied to the ac loop amplifier (A22-10). The ac gate pulse then switches this signal to the comb filter, consisting of three band pass circuits (A22, A23, A24). The purpose of the comb filter is to maximize the servo gain at three critical frequencies: 60 Hz, 120 Hz, and 180 Hz for 525 line use, and 50 Hz, 100 Hz and 150 Hz for 625 line use. The three comb filter outputs are combined and amplified (A23-10), then routed to the AST Servo PWA (signal COMB FILTER OUT), to be summed with the servo error signal.

2-106. Variable Reference Circuit. This circuit provides a variable reference signal which is used by the Scanner Servo PWA in generating the vertical servo output during slow motion operation. The inputs to the variable reference circuit are an AST head position signal, an inverted jump trigger signal, and a variable reference trigger. The AST position signal, from the AST Servo PWA, is sampled and held (Q1, C48) at a time determined by the advance tach pulse from the scanner servo. This sample is compared at a slicer (A31-7) to a ramp (Q4, R108, C51) that is initiated by a variable reference trigger from the Reference PWA. The resulting variable reference output provides a correction component for the position of the AST head in the slow motion mode.

2-107. Miscellaneous Circuits. The jump trigger generator is a one-shot triggered by the advance tach pulse from the scanner servo. The output provides the jump trigger pulse used by the AST servo to jump the AST head to an adjacent track. The timing, developed by the Scanner Servo PWA, ensures that head jumps will occur only during dropout.

The AST mode change timer (A1) is operative when the AST is on and the AST range switch is at EXT. The circuit changes the gating and signal levels to the comb filter in still mode and slow motion mode. This adds a component to the error signal to compensate for operating parameters that differ from those prevailing in the play mode.

The AST range extend circuit provides a longer lock-in period when tracking errors are larger than normally encountered. This circuit is activated by operator switch S1. The DS1 LED lights during a range extend operation, and a high EXT level is sent to the AST Servo PWA and to the ac/dc gate generator.

2-108. AST Driver PWA. This PWA, located just above the rear connector panel, provides drive to the AST head assembly. Refer to schematic diagram 1400255 and the block diagram, Figure 2-35.

The input drive signal form the AST Servo PWA has an ac component on the order of 300 mVp-p, superimposed on a dc level that ranges from +3V to −3V. This AST servo signal is applied to two voltage feedback amplifiers of opposite polarity. Positive and negative drive outputs of +250 Vdc p-p and −250 Vdc p-p are provided (pins 10 and 9). These outputs drive the flexure element on which the AST playback head is mounted.

The ac input power is rectified on board, to provide dc voltages of approximately +250V and −250V to the amplifiers. The two drive outputs from the board are disabled when the scanner is stopped, to eliminate the possibility of electrical shock during servicing of the scanner. This is

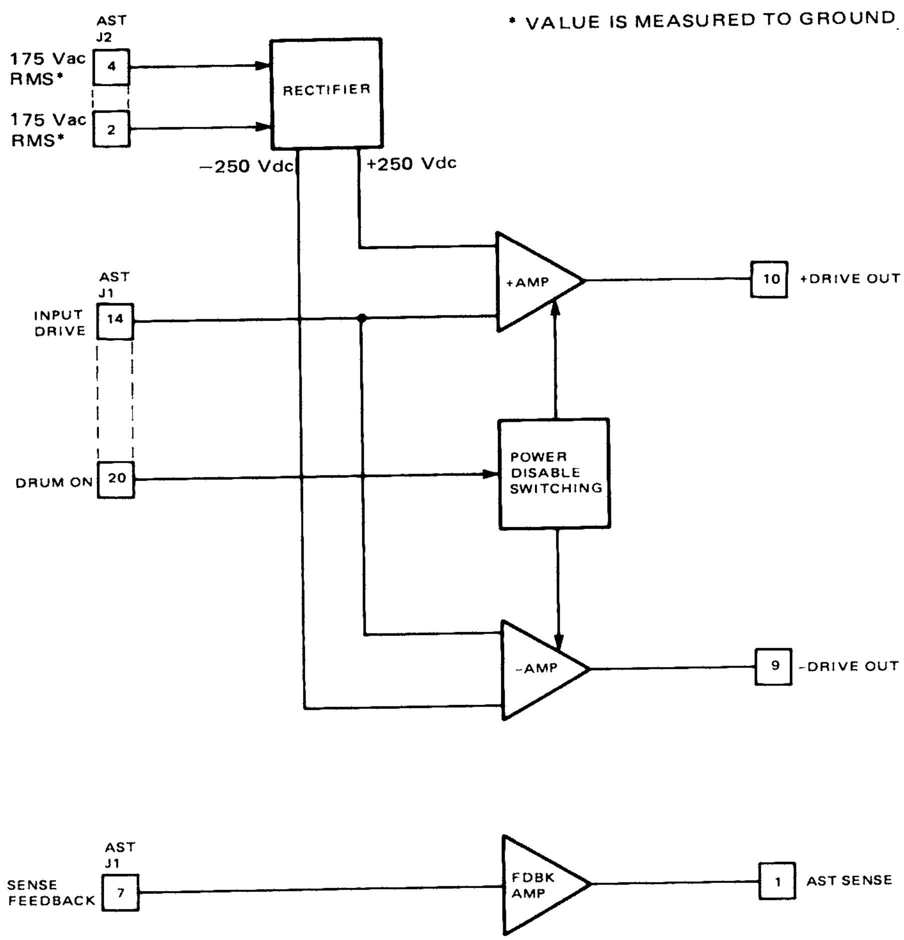


Figure 2-35. AST Driver PWA

initiated by the drum on signal, which opens a bilateral switch to disable both voltage amplifiers. The board also includes a one stage buffer amplifier for the sense strip feedback, for driving this signal to the AST Servo PWA.

2-109. Playback Sync PWA No. 8. This is a multifunction PWA (Figures 2-36 and 2-37 and schematic diagram Nos. 1400088 and 1400085). It generally provides the portion of the off-tape video signal processing that is not directly involved in the derivation of VPR video outputs. This processing includes:

- Generating rf meter amplitude levels.
- Developing most of the interfacing signals for the TBC.
- Supplying dropout interval information to the TBC and AST servo systems.
- Providing video/sync head switching commands to the video playback system.
- Supplying off-tape vertical information to the scanner servo.

Two versions of this PWA exist to accommodate both AST and non-AST models.

2-110. *Meter Signal Processing.* (Refer to Figure 2-36 and schematic diagram No. 1400088, sheet 1 of 2.) RF signals from the video/sync heads are routed to the Playback Sync PWA after amplification by the Equalizer PWA. Here they are processed by meter amplifier circuits. All three meter

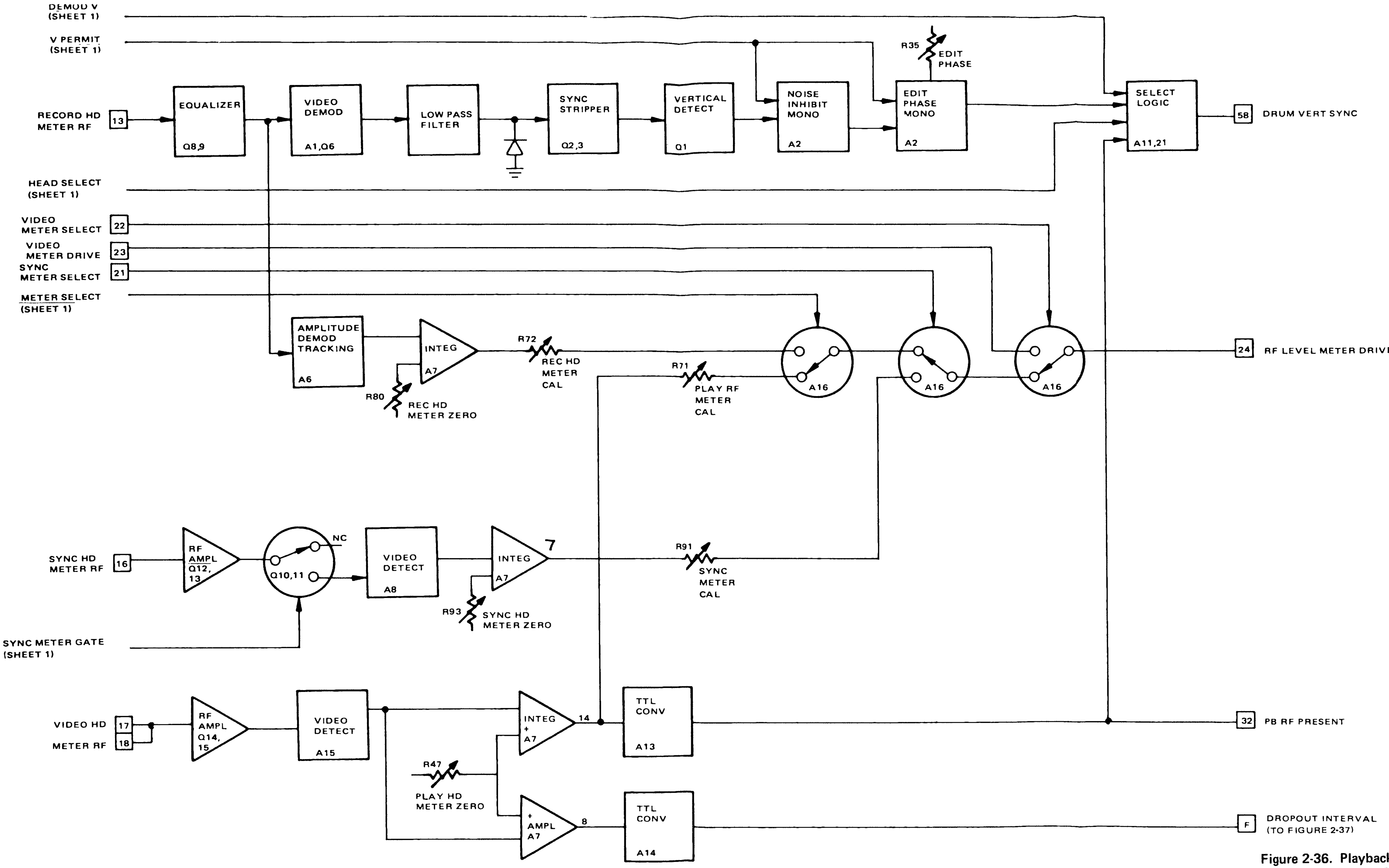


Figure 2-36. Playback Sync PWA, Analog Section

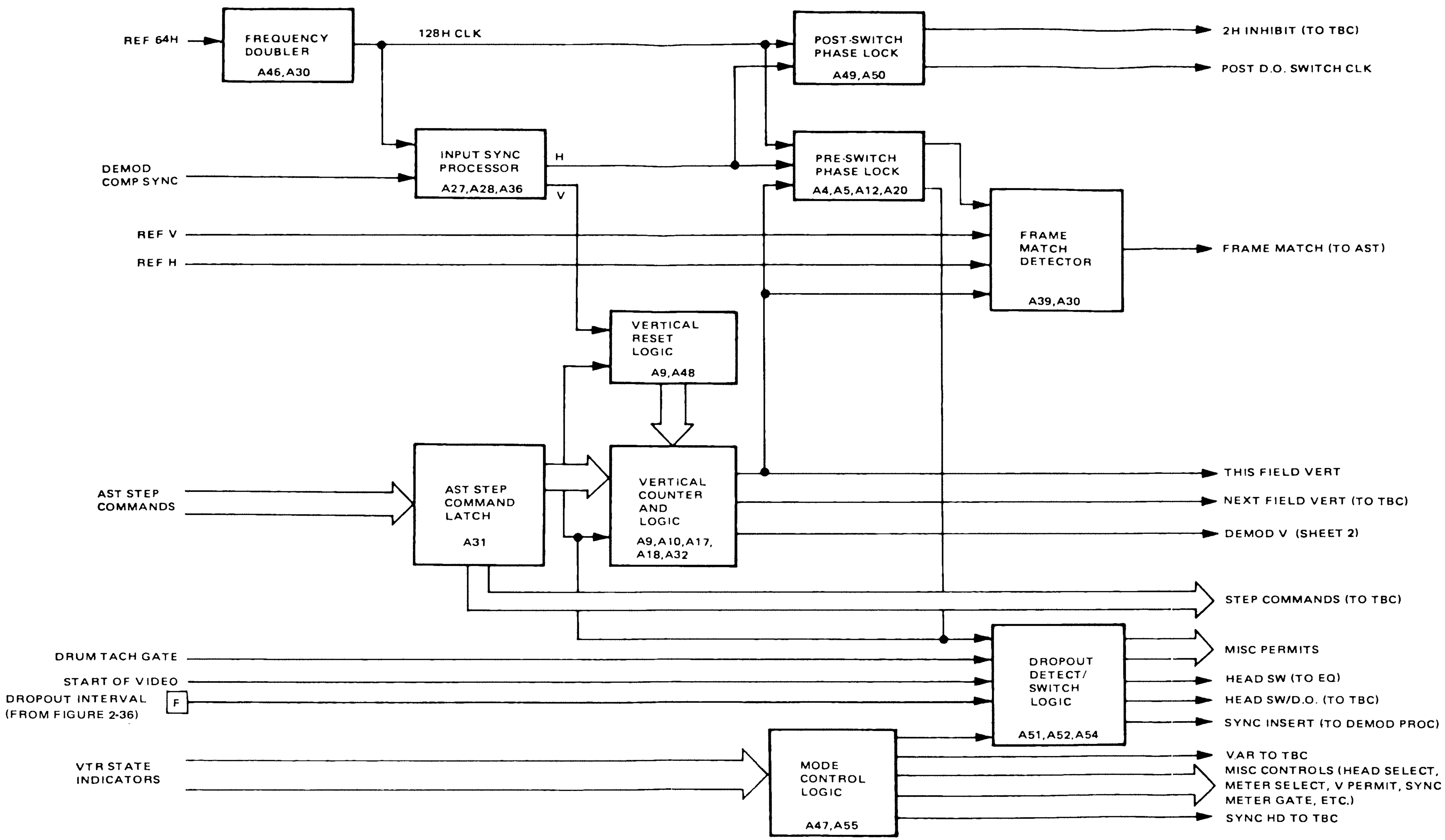


Figure 2-37. Playback Sync PWA, Digital Section

amplifier circuits are similar in overall function, but vary in implementation methods.

Video play head rf is amplified by a two-transistor circuit (Q14, Q15) and then processed through an am detector I.C. (A15). The signal at A15-4 is a dc level which varies with rf envelope amplitude. From there, the signal is routed to two circuits. First, it is level-shifted and gain-controlled by integrator A7-14, then routed to the meter select switches for possible use to drive the RF LEVEL/VIDEO meter. The A7-14 output is also routed to comparator A13-7 which produces a TTL logic level routed to the AST servo system as an indication that playback rf is present. Second, the detected envelope is processed through an amplifier. This circuit is used to help other circuitry decide when to switch from sync head playback to video head playback.

The sync head rf meter amplifier circuitry is similar, except it must be gated to measure only the sync head portion of the rf at its input. The resulting signal at A7-7 is a pulse which is integrated before being passed to the meter select switches.

The record head rf meter circuitry is similar to that previously described, but it also includes a simple demodulator, sync stripper, and vertical sync detector. When the VPR is in an edit playback mode, the scanner system must position the record head relative to input video and it must vertically servo for proper edit phase matching. In an AST-equipped system, the demodulator may already be producing play head video. The extra circuitry is necessary to process record head rf under these conditions. Vertical sync detected by this demodulator is routed back to the scanner servo system. Under all other conditions, the vertical sync is derived by the main portion of the Playback Sync PWA.

Meter selection and switching is nominally under operator control by a select switch on the control panel. Normally the meter will indicate video play head rf level. However, when the VTR is in the playback portion of a video edit, circuitry on this PWA automatically provides record head rf to the meter instead of play head rf. This is necessary to permit proper tracking of the VTR for editing.

2-111. *Horizontal Sync Processing.* (Refer to Figure 2-37 and schematic diagram No. 1400088, sheet 2 of 2.) Digital operation is used for the main body of the PWA. This operation is based upon a a 64 X H master reference clock from the Reference PWA which is doubled to 128H, then used to clock all the horizontal rate circuitry.

VTR output composite sync (referred to as "demod comp sync" on Figure 2-37) is routed to the PWA from the demodulator PWA. It is processed here by an input sync processor section consisting of A26, A27, A28, and part of A36. The function of this circuitry is to provide noise immunity to the sync signal and to sort our horizontal from the twice horizontal information that is sometimes present during the vertical interval. The composite sync signal is also processed through a vertical sync detector (A43). Vertical sync is detected by looking for the pre-equalizing pulses that occur before. When the second equalizing pulse occurs, this circuit outputs a pulse. The reason for this type of detection is that actual vertical sync broad pulses will not always exist in playback, especially during variable speed operation. However, the first two equalizing pulses can always be recovered.

Horizontal sync information from the input sync processor is routed to two places: a pre-switch, phase-locked horizontal network (A4, A5, A12, A20, and associated circuits) and post-switch, phase-locked horizontal network (A4, A5, A12, A20, and associated circuits) and post-switch, phase-locked horizontal network (A49, A50).

The pre-switch horizontal network has two critical requirements. First, it must produce a reliable 2H clock signal which will be used to drive all vertical circuits. This clock must be immune to any step-function changes in off-tape video timing and must accurately meter the exact number of horizontal lines of video between vertical sync periods. Second, this clock must be accurately phase matched to off-tape video in the period immediately preceding the vertical sync region, and also through most of the normal dropout interval.

Normal skew errors encountered in VTR playback produce a step function difference in video timing between sync that occurs just before the vertical interval dropout interval, and sync just after the dropout. When the VPR is operating with the sync head option enabled, the skew error occurs when the switch is made from video head playback to sync head playback. This switching takes place in the middle of equalizing pulse (2H) information. To prevent the TBC from locking onto the wrong equalizing pulse, it is necessary to provide the TBC with an estimate of where the sync will be after the switch.

The post-switch horizontal circuitry samples off-tape sync phase after the dropout interval and remembers this phase for a full field. This information is used by the TBC before and during the next dropout interval to provide discrimination of equalizing pulses. It is also used by other internal circuitry to determine when to switch back from the sync head to the video head.

2-112. *Vertical Sync Processing.* Vertical sync is normally considered to be the first part of a video field. This fact can cause some confusion in a Type C format VTR because the VTR records vertical sync at the last part of the track. In normal playback this is not a problem because off-tape video is continuous. In AST playback, however, when the AST system chooses to jump tracks, the normal playback track sequence is altered, As a result, the last information on the track before the jump does not represent vertical sync of the track that is about to be placed. Furthermore, there are no longer the same number of horizontal video lines between two successive vertical sync intervals. Under these conditions, vertical sync processing becomes complex.

AST system sends this PWA a set of jump commands (referred to as "AST step commands" in Figure 2-37) early enough to notify the sync processing circuitry that it will execute a jump during the dropout interval; also, what kind of jump will be executed. This information is latched and held until no longer needed. In addition to providing data for interval vertical circuitry, the latches also notify the TBC of impending track jumps.

The vertical counter circuit consists of A9, A10, A17, A18, A32 and associated circuitry. It is clocked by the 2H clock signal from the preswitch circuit. It operates at a vertical rate and maintains a known phase relationship to the actual off-tape vertical sync in all playback modes of operation. In variable speed modes, AST track jump information modifies the number of lines the vertical counter will count so that it can retain its relationship with off-tape video. A vertical reset network (A9, A48) compares the counter phase with detected off-tape vertical sync and resets the counter if it is wrong. The vertical reset network releases a second counter/timing network shortly before the vertical sync period starts, and permits it to run throughout the vertical interval.

The vertical pulse generator network (contained within the vertical counter and logic block in Figure 2-37) consists of A25, A33, A34, and A42. It receives a vertical related release signal, a pre-switch generated 2H clock, and AST step commands. From this information, it generates predicted vertical sync pulses which represent vertical sync phase of the field about to be played. (This information is routed to the TBC and to the composite sync generator portion of the pre-switch phase circuitry.) It also generates a vertical sync pulse which represents the portion of off-tape video to be used by the scanner servo system. Finally, it creates video timing gates which will be used by internal PWA circuitry to determine when to switch between video and sync play heads.

2-113. *Video/Sync Head Switching.* The determination of when to switch from the video play head to the sync head and back again is an important function of this PWA. This decision is determined primarily by the video play head dropout interval, which is not directly related to video content (vertical sync, etc.). Dropout interval is related to head position as indicated by the scanner tach. Under normal conditions, the scanner tach signal (referred to as "drum tach gate" in Figure 2-37) triggers a counter timing system (A22, A29) which operates throughout the dropout interval. A dropout switch logic network (A37, A45, A51, A52) combines dropout detect information from the meter amplifiers, video related sync phasing information both pre- and post-dropout clocks, and its own timing/programming

information. It creates a head switch pulse which is used by the video system to switch the playback head signal. It is also used by the AST servo and the TBC, and provides miscellaneous dropout-related gates which aid other circuits within the PWA.

A47 and A55 form the mode control logic center of the PWA. Along with several VTR mode control signals and an operator select switch, this circuitry determines which rf signal should be routed to the meter, whether the sync head signal should be processed, and whether the AST step commands should be acknowledged.

2-114. Playback Sync Processor (Non-AST) PWA No. 8

This PWA provides various signal processing functions for the off-tape video, including:

- Generating rf meter amplitude levels.
- Developing most of the interfacing signals for the TBC.
- Supplying dropout interval information to the TBC.
- Providing video/sync head switching commands to the video playback system.
- Supplying off-tape vertical information to the scanner servo.

Refer to the playback sync processor (non-AST) block diagram, Figures 2-38 and 2-39, and schematic diagram 1400085. The following circuit descriptions of this board refer to 525 line use and 625 line use.

2-115. Meter Signal Processing. Refer to sheet 1, analog section, of Figure 2-38. The rf signals from the video and sync heads are routed to the playback sync processor after amplification in the equalizer board. The three meter rf processing circuits are similar in function, but vary in circuit details.

Video head rf is amplified then routed through a detector (A8) and parallel integrators (A2-8, A2-14). A play head meter zero adjustment is provided (R8). One integrator output (A2-14) is applied to the meter select switching for driving the RF LEVEL/VIDEO meter, and is also routed to the AST servo system (via comparator A6) to indicate the presence of rf (signal P/B RF PRESENT). A play rf meter calibration adjustment is provided by a potentiometer (R48). The other comparator output sends a dropout interval signal to the dropout detect/switch logic circuit (Figure 2-39).

The sync head rf meter circuitry is similar, except it must be gated to measure only the sync head portion of the rf. The signal is am detected and grated, and applied to meter select switching. A sync meter zero adjustment (R17) and a sync meter calibration adjustment (R63) are provided.

The record head rf, similarly, am detected integrated and applied to meter select switching. A record head meter zero adjustment (R9) and a record headmeter calibration adjustment (R49) are provided.

Meter selection and switching is nominally under operator control by a select switch on the control panel. Normally the meter will indicate video play head rf level. However, when the VTR is in the playback portion of a video edit mode, circuitry on this PWA automatically provides record head playback level rf to the meter instead of play head rf level. This is necessary to permit proper tracking of the VTR for editing.

2-116. Horizontal Sync Processing. The board recieves playback composite sync from the demodulator and a reference 64 X clock from the reference board. (Figure 2-39.) Using the reference clock, it tracks the off-tape H at any playback speed, accurately predicting H (and V) sync during dropout. This is accomplished digitally.

The 64 X H clock signal is doubled, and clocks an input sync processor circuit (A21, A22). This circuit includes a counter which is reset by off-tape H and is clocked by the 128 X H reference signal. A PROM (A21) provides an output which inhibits gating of the off-tape H pulse until 2 μsec before the pulse occurs, for noise immunity. The output

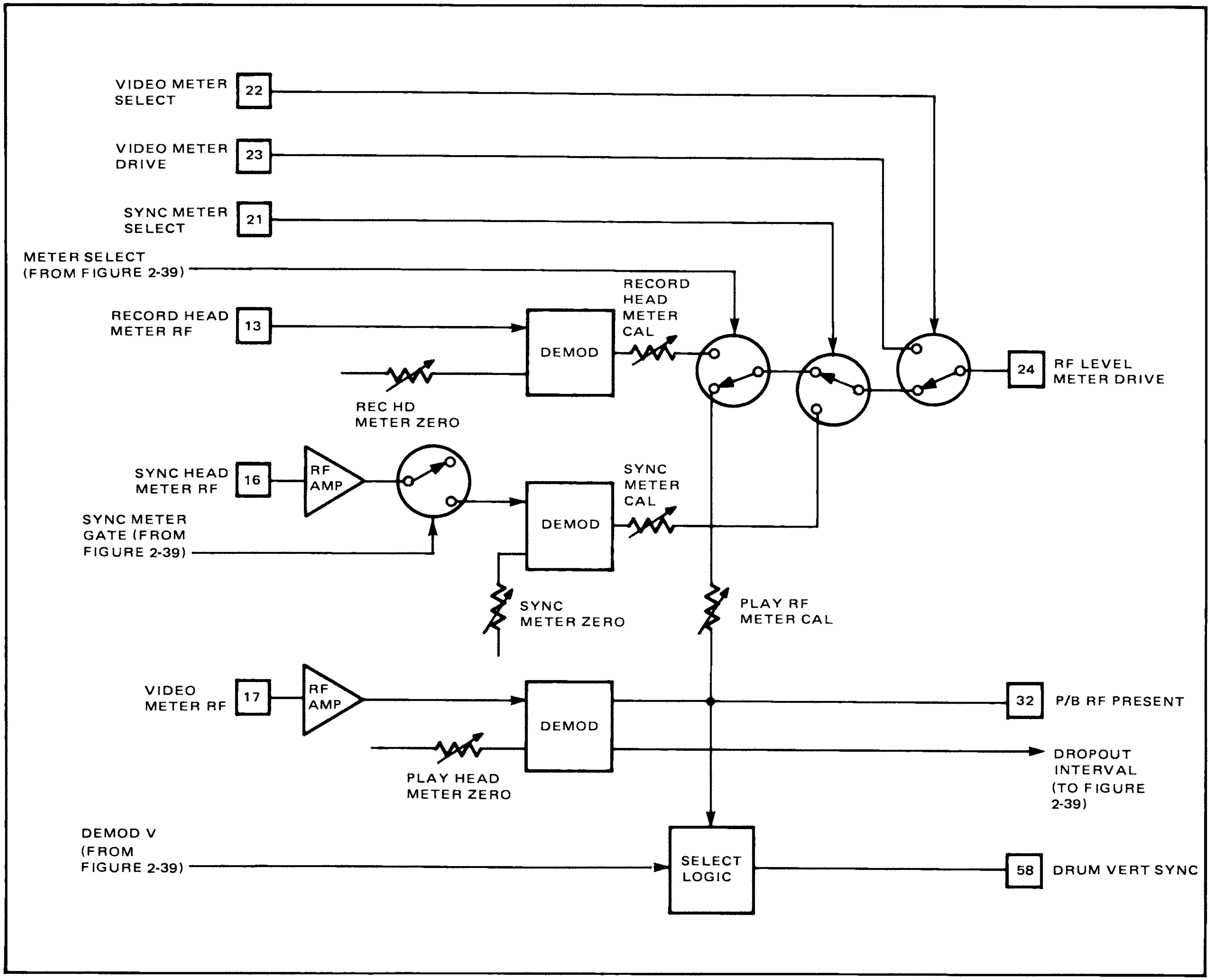


Figure 2-38. Playback Sync Processor (Non-AST) Block Diagram, Analog Section

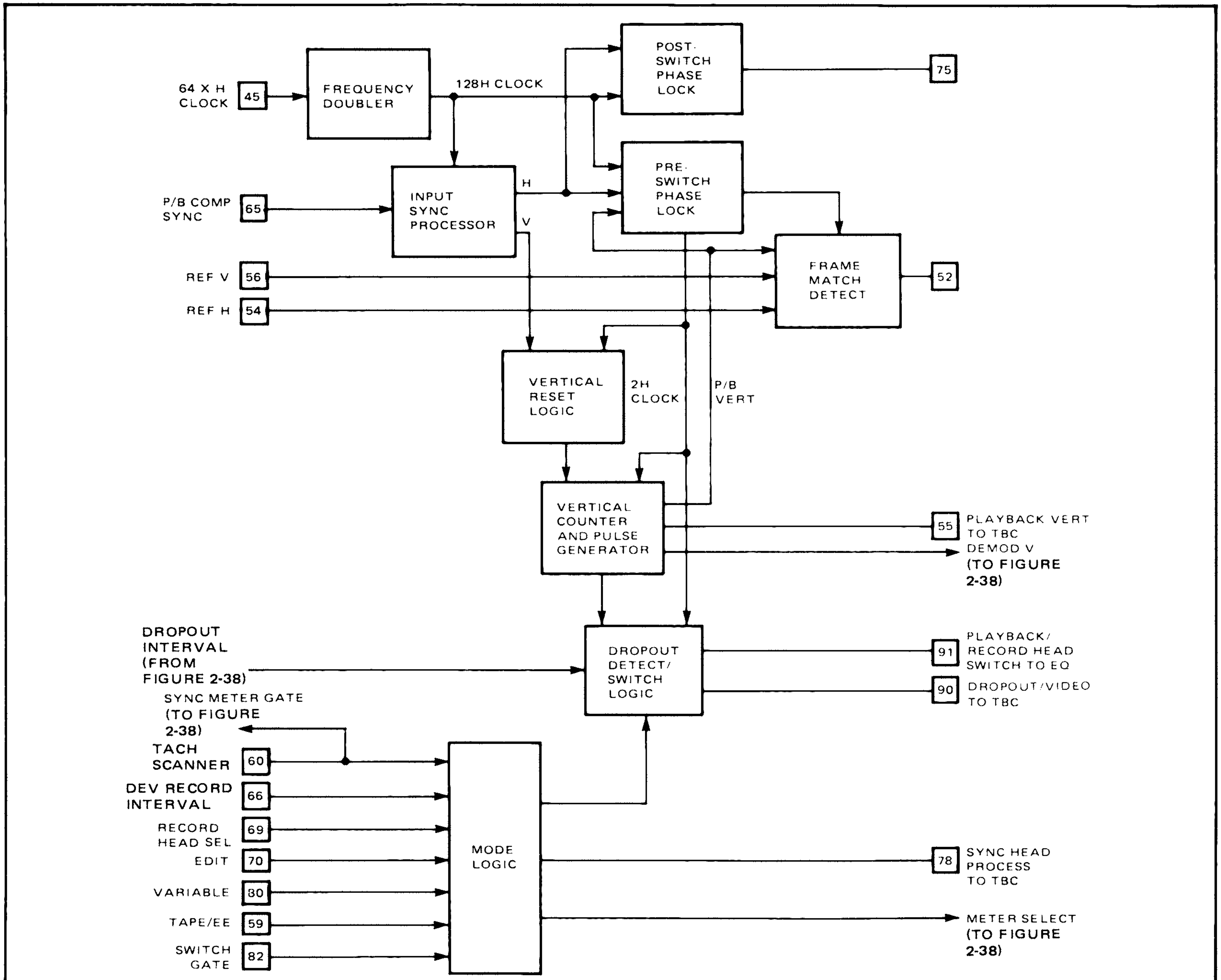


Figure 2-39. Playback Sync Processor (Non-AST) Block Diagram, Digital Section

of this counter represents the actual phase of off-tape H sync.

Horizontal sync information from the input sync processor is routed to the pre-switch phase lock circuit (A5, A10, A11) and to the post-switch phase lock circuit (A26, A27).

The pre-switch network provides tracking of off-tape H sync for all playback speeds. A counter is clocked by the reference 128 X H signal and the resulting H output is compared to the off-tape H signal in a slewing circuit. This slew circuit changes the counter loading, as needed, to produce an H output that is phase locked to the off-tape H. During dropout the playback composite sync is inhibited, for noise immunity reasons. Therefore, this circuit is needed to provide an accurate indication of H sync pulses, during dropout. Its 2H output is used for clocking purposes, making possible an accurate estimate of off-tape V sync. A primary purpose is to provide accurate V sync information just prior to switching to the sync head.

Also, an H output from the pre-switch circuit (A11-12) is used to generate a playback frame signal. This signal is compared to a reference frame signal, in a frame match detector (A24-8, A14-5). The resulting frame match signal is sent off the board.

Normal skew errors encountered in VTR playback produce a step function difference in video timing between sync that occurs just before the dropout interval and sync just after dropout. When the VPR is operating with the sync head option enabled, the skew error occurs when the switch is made from video head playback to sync head playback. This switching takes place in the middle of equalizing pulse (2H) information. To prevent the TBC from locking onto the wrong equalizing pulse, it is necessary to provide the TBC with an estimate of where the sync will be after the switch.

The post-switch horizontal circuitry samples off-tape sync phase after the dropout interval and remembers this phase for a full field. This information is used by the TBC before and during the next dropout interval to provide discrimination of equalizing pulses. It is also used by other internal circuitry to determine when to switch back from the sync head to the video head.

2-117. Vertical Sync Processing. The composite sync signal is also processed through a vertical sync detector (A9). Playback vertical sync is detected by looking for the equalizing pulses. When the second pre-equalizing pulse occurs, this circuit outputs a pulse (A9, A25). The reason for this type of detection is that actual vertical sync broad pulses well not always exist in playback, especially during variable speed operation. However, the first two equalizing pulses can always be recovered.

Noise immunity is provided for this circuit by a signal from the input sync PROM (A21). Based on off-tape H information, this PROM sends a gating pulse (eq gate) only when needed for the expected equalizing pulses.

The vertical counter and pulse generator circuitry is clocked by the 2H signal from the pre-switch phase lock circuit. The vertical counter (A33, A34, A35) follows the off-tape V sync. At some time prior to dropout this counter releases a second counter (A20) in the pulse generator network. This second counter then meters out 1/2 H time intervals during dropout. The vertical pulse generator (A20, A28, A36) produces various vertical outputs based on predicted vertical interval information.

The vertical counter circuitry is a self-reset circuit that operates at a vertical rate. It maintains a known phase relationship to the off-tape vertical sync in all playback modes. The vertical counter V output and the off-tape V are compared in the vertical re-phase circuit, and if they disagree in phase eight fields in a row, the off-tape V causes resetting of the vertical counter, to the proper phase.

The vertical pulse generator receives a vertical related release signal and a pre-switch generated 2H clock. From this information, the PROM (A28) generates predicted vertical sync pulses representing sync phase of the field about to be played. TBC vertical, a predicted vertical sync pulse, is sent to the TBC. A demod V pulse is used to gate the drum vertical sync at the leading edge of the second broad pulse of playback comp sync. A playback vertical signal (TP8) is used in the playback frame circuit. The pulse generate circuit also provides head switch gating outputs.

2-118. Video/Sync Head Switching. Head switching depends on the dropout interval, which is primarily based on mechanical geometry rather than on video content. Therefore the scanner tach signal, "drum tach," provides the basic information for head switching decisions. Normally, via the mode logic circuit, the drum tach signal triggers a counter timing system (A37, A38) which operates throughout the dropout interval. A dropout switch logic netwoerk (A45, A46, A47, A48) combines dropout detect information from the meter amplifiers, video related sync phasing information, pre-switch and post-switch clocks, and the tach gate PROM (A46) program. This network provides a head switch pulse (pin 91) to the equalizer to select either the video playback or the sync playback. This pulse is also used by the TBC, and provides other dropout-related gates within the playback sync processor.

Two PROM outputs used for switching from video head to sync head are the switch must and switch may signals (A45-10, 14). Switching to sync head, if done, may occur during the switch may gate, and must occur during the (narrower) switch must gate. The dropout interval signal is also needed, and the exact timing is provided by two outputs of the vertical pulse generator.

To switch from sync head to video head requires a signal form the dropout detector indicating the presence of play head rf. The timing is provided by the post-switch phase lock circuit. The post switch PROM (A27) puts out a clocking pulse about 4 μsec before the next H sync, to initiate head switching.

Sometimes the record head is being played through the demod. As it has no sync track, all the sync information has to be generated. The scanner tach represents the position of the play head, not the sync head, so another position indicator must be used. A PROM on the reference board provides a pulse indicating that the record head is near dropout. This pulse provides the switch gate signal to the logic PROM (A32), triggering the tach gate circuitry.

2-119. Mode Logic Circuit. Refer to Figure 2-39. The mode logic circuit (A32, A40) accepts various logic inputs and provides a number of outputs in addition to those involved in head switching. This circuit determines which rf signal should be routed to the meter, which head should be used for vertical sync purposes, and whether the sync head signal should be processed. It also enables a DO/V pulse, which is sent to the TBC.

2-120. Scanner Servo PWA No. 11

The scanner servo system consists of the Scanner Servo PWA, the scanner motor, the scanner portion of the motor drive amplifier (MDA), the scanner motor, and the scanner tach. This system controls the speed and rotational position of the scanner head motor in all modes of operation, keeping the head positioned accurately relative to reference timing information.

Refer to Figure 2-40, scanner servo system block diagram. The Scanner Servo PWA drives the scanner motor via the MDA. The printed circuit dc motor drives the upper scanner drum at a field rate. A once-around phototach assembly generates a 60 Hz (50 Hz) vertical rate feedback pulse (drum tach). The Scanner Servo PWA also receives feedback from the playback sync processor, and receives reference signals from the Reference and AST Filter PWA's.

The Scanner Servo PWA controls the scanner motor by means of velocity servo and a tach position (phase) servo. The tach position servo receives its reference from a floating tach reference system.

Refer to Figure 2-41, Scanner Servo PWA block diagram, and schematic diagram 1400115. The scanner tach signal is applied to the velocity servo and to the tach position servo. Reference vertical signals and a reference 64 X H clock signal are applied to the floating tach reference system, which provides a tach reference signal to the tach position servo. The floating tach reference system may receive vertical feedback from the Playback Sync Processor (P/B vert), or from its own circuitry, or it may operate in a locked mode using no feedback. System status signals are applied to logic circuitry for automatic selection of one of these three operating modes. Also, the Scanner Servo PWA includes a scanner stall sensing circuit, for circuit/tape protection. The following circuit descriptions of this board refer to 525 line use and 625 lines use.

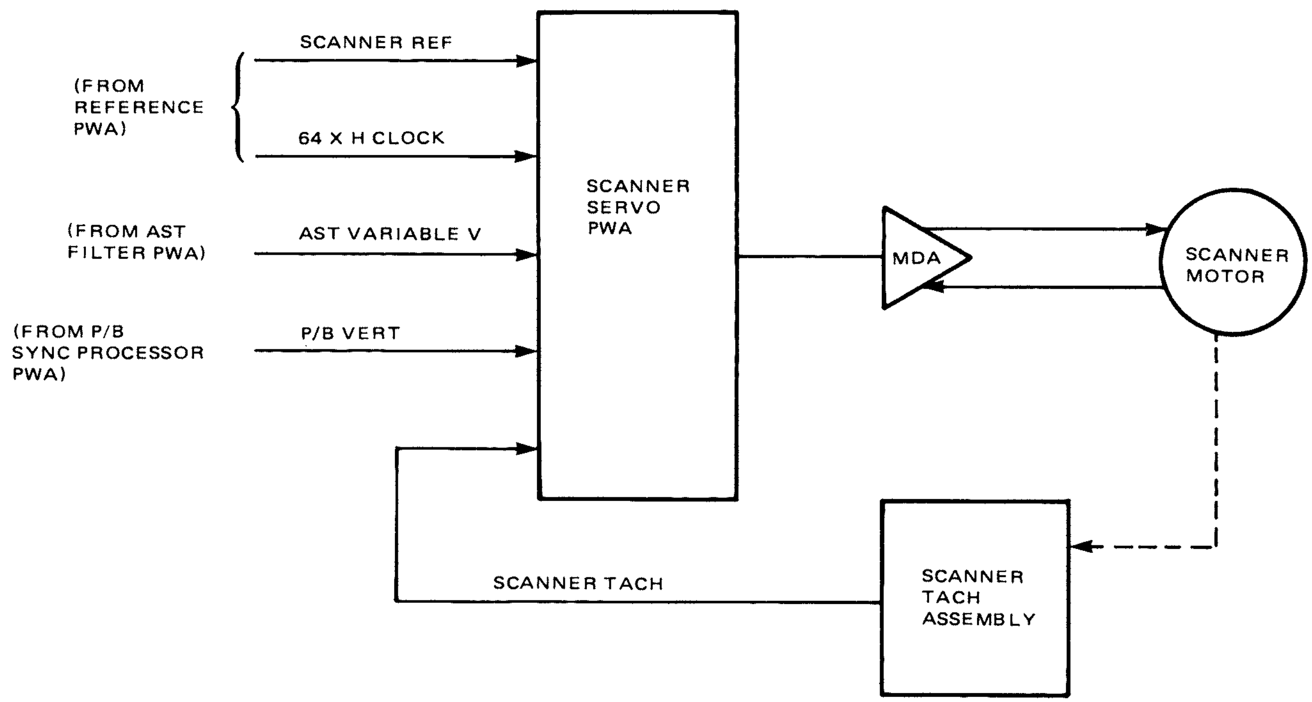


Figure 2-40. Scanner Servo System Block Diagram

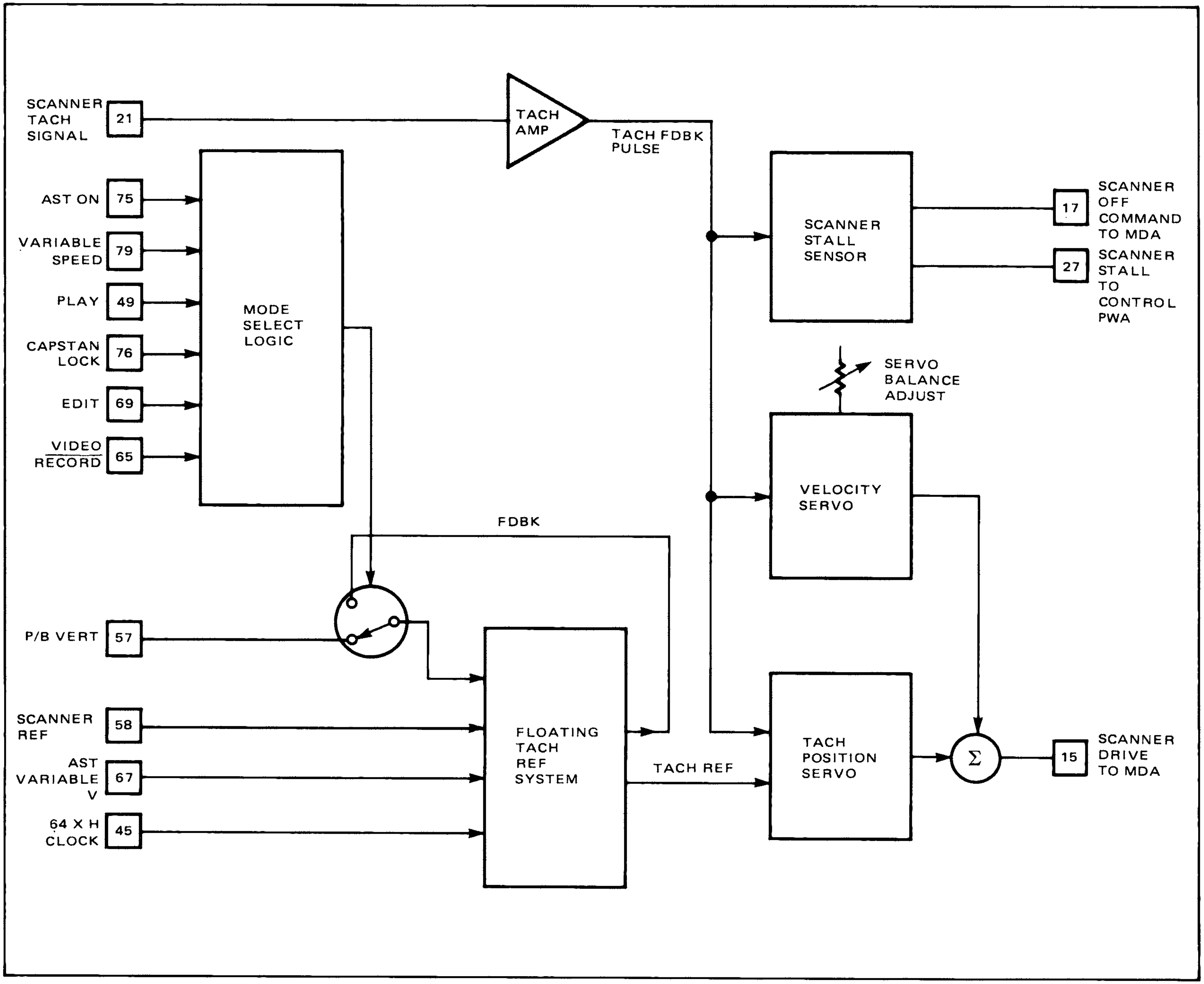


Figure 2-41. Scanner Servo PWA Block Diagram

2-121. Floating Tach Reference System. This system provides a floating reference signal to the tach position servo, allowing it to position the head correctly relative to tape. The floating tach reference (FTR) system has three modes of operation: vertical servo, tach servo, and locked FTR (no servo).

Refer to the FTR block diagram, Figure 2-42. The mode select logic receives a number of system-state input signals and selects one of the three operational modes. The remaining FTR circuitry includes a self-resetting vertical rate counter, and shift logic for initiating slewing of the output by altering the counter loading. Each FTR operational mode is described separately, in the following paragraphs.

2-122. *Vertical Servo Mode.* This mode is used in normal playback and in edit playback. It produces a field rate signal (tach ref) with a resolution of one microsecond. In this mode, the reference vertical (scanner reference) is compared to a feedback signal (scanner vertical) from the playback sync processor. If they are out of phase, the tach reference output is adjusted in increments of 1 microsecond per field. This allows the scanner head to be brought precisely into phase, by means of the tach position servo.

The fine adjustment of the tach reference signal is accomplished by the vertical rate counter/PROM circuitry (Figure 2-42) when initiated by the vertical servo logic, via the shift logic. The vertical rate counter (A22, A29, A36) divides the 64 X H reference clock through 15 stages of counting. The counter, through coarse gate and fine gate PROM's, creates a self-reset signal which sets the counter to zero to start a new count sequence. A pulse is generated from the two most significant bits of the counter, to provide the tach reference signal. Count zero is considered the reference edge.

The counter phase, relative to the VTR reference, can be shifted in 1 microsecond increments to any phase desired. This is accomplished by parallel loading of the first counter (A22). The fine gate PROM generates a shift gate pulse after this counter reaches count 8. If the tach reference signal needs to be shifted, the shift monostable (A9-4) generates a load command used by this counter at the next clock pulse. The parallel load inputs are set to load either an 8 or a 10 (when the counter would normally reach 9). The number loaded depends on the state of a direction latch (A21-6) of the shift logic. Loading an 8 adds 1 microsecond to the total time interval of the counter system, resulting in a phase lag. Loading a 10 subtracts 1 microsecond.

The need for shifting is detected by the vertical servo logic. The reference vertical signal (scanner ref) together with a 1/2-field delay signal, operates a flip-flop (A28-8). The negative edge of this flip-flop output is the reference position. It triggers an 8 μsec dead zone during which the scanner vertical signal is looked at.

There is always some jitter in off-tape vertical information. The floating reference should not attempt to follow this jitter, as this would aggravate. Rather, the floating reference should be centered on the jitter, so the average off-tape vertical conforms to reference vertical. The scanner vertical signal is delayed 4 μsec (A9-5) to occur in the center of the 8 μsec dead zone signal (A25-12) when scanner vertical is in phase with the reference signal. Both signals are applied to an error detect gate (A38-6) which is enabled during vertical servo mode.

When playback video is out of phase by more than ±4 μsec, a pulse passes through A38-6 and sets a shift latch (A21-8). A direction latch (A21-6) looks at the reference to determine the direction of shift. Subsequently, an 8 or a 10 will be loaded into the first counter, causing a 1 microsecond shift. The shift monostable (A9-4) will be disabled until the next field (at which time, another phase error may exist).

2-123. *Tach Servo Mode.* This mode is used in standby, shuttle, slow motion, and normal record. It produces a field rate signal (tach reference) that can be rephased at a rate of up to 1H per field. In this mode, the reference vertical (scanner reference) signal is compared to a feedback signal generated by the vertical rate counter/PROM circuitry. This feedback signal represents a nominal vertical position. Changes in the reference vertical signal produce corresponding changes in the tach

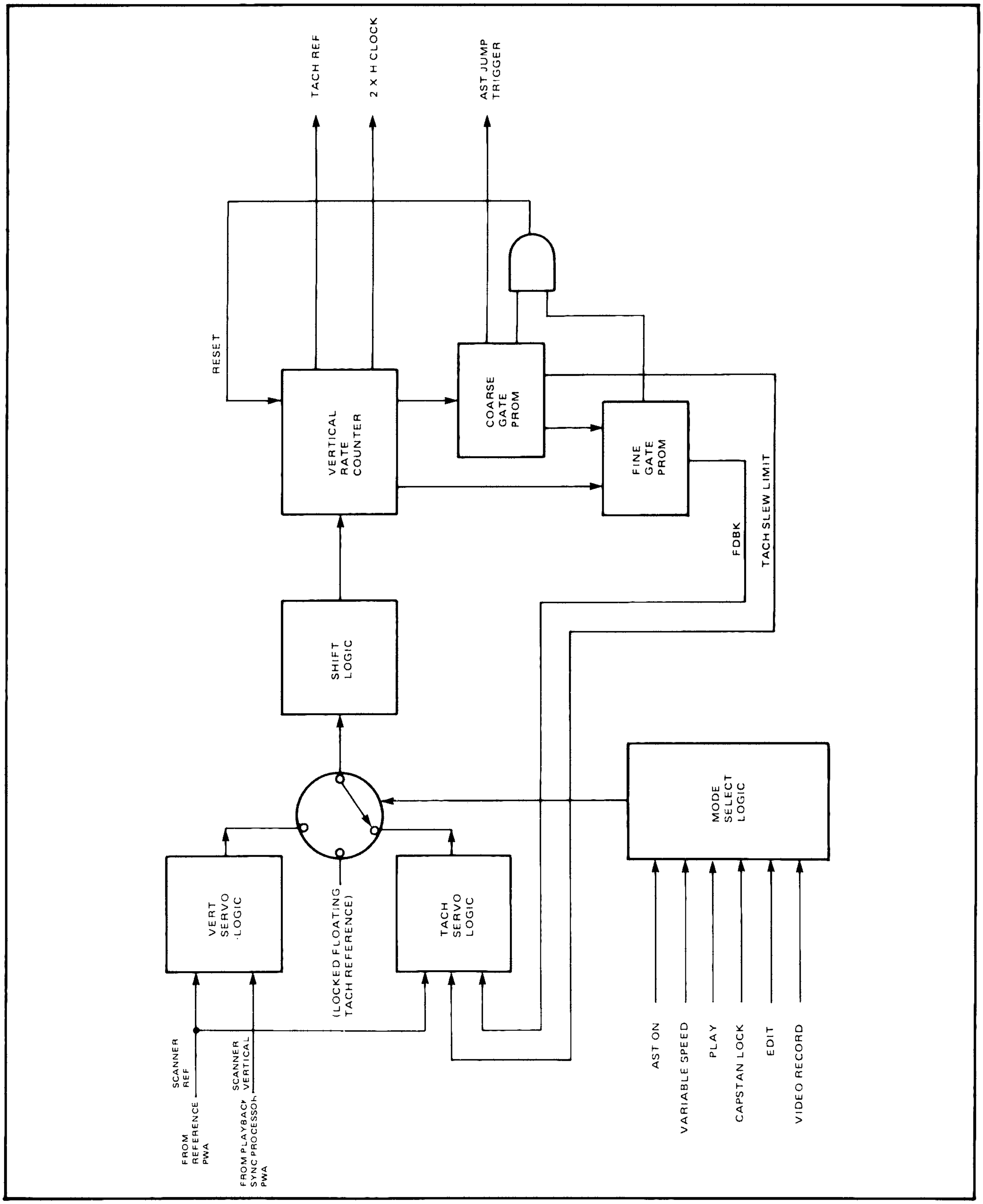


Figure 2-42. Floating Tach Reference System Block Diagram

reference output, bringing the scanner head into phase with the reference signal.

As in the vertical servo mode, the reference position is denoted by the negative edge of the A28-8 output pulse. The floating tach feedback pulse (A30-10) is compared with this pulse in a digital phase detector (A17-8). Any phase difference produces an output pulse having a width proportional to the phase error. This error signal activates the shift logic via an error gate (A14-8) which is enabled in tach servo mode.

Shifting of the tach reference output signal is accomplished in the same manner as in vertical servo mode; an 8 or a 10 is parallel loaded into the vertical rate counter. However, shifting will repeat every 16 clock pulses ($\approx$16 μs), for the duration of the error signal. This is because the error signal keeps the shift latch (A21-8) cleared, enabling the shift monostable (A9-4).

The correction rate is 1 μs every 16 μs, as the tach reference signal can be shifted one clock count every 16 clock periods. When a large error exists, the resulting correction rate would be too great for the scanner to respond to. Therefore a maximum shift rate is established. This is the tach slew limit, generated in the coarse gate PROM (A37-14). It is applied to the error gate (A14-9), and is programmed to permit a maximum slew rate of 1H per field.

When a scanner servo is suddenly presented with a large phase error it has a tendency to hunt and ring, before setting, which can impair picture quality. The floating tach reference system, however, prevents this by moving the scanner to the new phase at a controlled rate.

2-124. *Locked FTR Mode.* This mode is used in edit record. During edit playback, the vertical servo logic maintains the off tape video phasing, relative to the reference. When the machine switches to edit record the vertical servo logic remains activated (precluding tach servo operation) except that the vertical monostable (A9-5) is inhibited. Therefore no error pulses occur, and the FTR system is locked to the last known position, for the duration of the edit recording. Thus the newly recorded video is properly phased to the video previously recorded on the tape.

2-125. Head Selection. There are two video heads in the VPR which may require position control: the record head and the play head. During normal playback operation, the play head must be timed to the VTR reference. During edit modes and all video record modes, the record head must be phased to incoming video.

The position of any element on the scanner, relative to the scanner tach pulse, is known with great accuracy. Thus the floating tach PROM's can be programmed to identify this position. A record head select signal is generated to select either play or record head phasing as required. Switching between heads requires the floating tach reference system to slew by 1/3 field. The resulting head position is used by the referencing system in its servoing operations.

Similar circuitry in the Playback Sync PWA selects the source to be fed back to the scanner servo. Thus the vertical servo circuitry is always operating from the correct head.

2-126. Tach Amplifier. Refer to Figure 2-41. Both the tach position servo and velocity servo receive information from a scanner photo-tach system. The system pickup device contains a disc with a narrow slot, located between a photo source and a photo-transistor. Both the source and the pickup are high frequency devices with focusing lenses. Thus, the resulting tach pulses are narrow and sharp. The tach system is adjustable at the scanner, thus providing positional adjustment with respect to the actual location of the video heads in the upper drum of the scanner.

The first two transitors of the tach amplifier form a current amplifier. The system is operated with the phototransistor in its linear range; thus the signal out of the amplifier is a negative voltage pulse shaped somewhat like a sine-squared pulse. This pulse is directed through a differentiating amplifier which produces an approximate sine-wave pulse. It is important to note that the zero crossing of that pulse occurs exactly at the peak of light intensity.

A slicing amplifier produces a positive transition at this zero crossing. This output is routed to a relatively long period noise-immunity monostable

to prevent additional transitions from appearing to the machine as tach pulses. Finally, the leading edge of the noise-immunity monostable triggers a pulse-former. The result is a 10-μs tach feedback pulse used by the tach position servo, velocity servo, and other systems within the VPR.

2-127. Tach Position Servo. The tach floating reference signal and the tach feedback pulse from the tach amplifier (A8-4) are applied to a digital phase detector. (See Figure 2-43.)

The two error pulses drive a charge pump. Depending on the direction and amount of error, the charge pump either drives charge into a capacitor (C18) or draws current from it. The charge level controls the position error amplifier, to provide the tach position error signal to the MDA. The velocity error signal is added to this signal and the sum is applied to pins 15/16.

The position error amplifier has a relatively narrow range of operation. Thus it is desirable to keep it centered in its range. The velocity servo has a much wider operating range. To keep both servo systems within their ranges. a balance adjustment is provided for the velocity servo.

A scanner speed low signal, indicating the scanner is not up to speed, closes a switch shunting the position error amplifier. This shuts off position error voltage to the sum point. When proper scanner speed is reached, the tach position servo can then start from a zero error condition.

2-128. Velocity Servo. The velocity servo loop (Figure 2-44) is a ramp and sample system. The ramp generator is clocked by the 2 X H reference clock, from the floating tach reference system. The ramp output (TP2) is sampled by the tach feedback pulse from the tach amplifier output. It is held in a capacitor (C2) and applied to the velocity error amplifier (A3-6). At each tach pulse, a monostable (A12-13) resets the ramp. Therefore the voltage applied to the velocity error amplifier is a measure of the time between tach feedback pulses; the more time between pulses, the greater the voltage.

The tach pulses occur once per revolution of the scanner, or, one field apart (at proper scanner velocity). Yet there is a very small frequency range over which the scanner should operate. If the ramp were to operate throughout the full field it would have a very shallow slope, making it hard to detect small differences in speed. For this reason, a digital circuit is included to freeze the ramp during most of the field. The clock for the freeze counter operates at a 2H rate. Two counts after the ramp starts, the freeze control monostable (A18-8) turns off the ramp current generator, freezing the ramp. A short time before the tach pulse is expected, the counter causes this monostable to turn the current generator back on, allow the ramp to proceed.

2-129. Scanner Stall Sensor. An integrator circuit is provided to limit the time that the Scanner Servo MDA may deliver current to the motor without producing scanner motion. This circuit protects both the scanner drive circuitry and the tape. The integrator is reset by scanner tach pulses received at the circuit input (A20-1). If no pulses are being created, a capacitor (C28) will charge up to the point where an RS flip-flop (A19-1, 4) will be set. This action shuts down the scanner drive and notifies the control system that the servo system is stalled. The control system then switches the VTR to a standby status. The standby command resets the integrator circuit, but keeps the scanner drive systems shut down.

2-130. Miscellaneous Circuits. The S1 (AUTO/TACH) select switch is used by the operator to force the floating tach reference system into tach servo mode, overriding automatic mode selection. As this is an abnormal situation, this lights the SYSTEM indicator. Also, a vertical limit detect latch (A32-6) can terminate vertical servo mode, and force the system to tach servo. As the vertical servo correction rate is comparatively slow, it is necessary for the tach servo to take over when abnormally large phase errors occur.

The scanner speed sensor (A2) is a comparator. When the sampled velocity error voltage from A1 is below a given level, the speed of the scanner is almost up to normal operating speed. The output of the speed sensor is used by the control system to permit the VTR to start moving tape in play and record modes of operation. It is used within the PWA to permit the position servo system to operate.

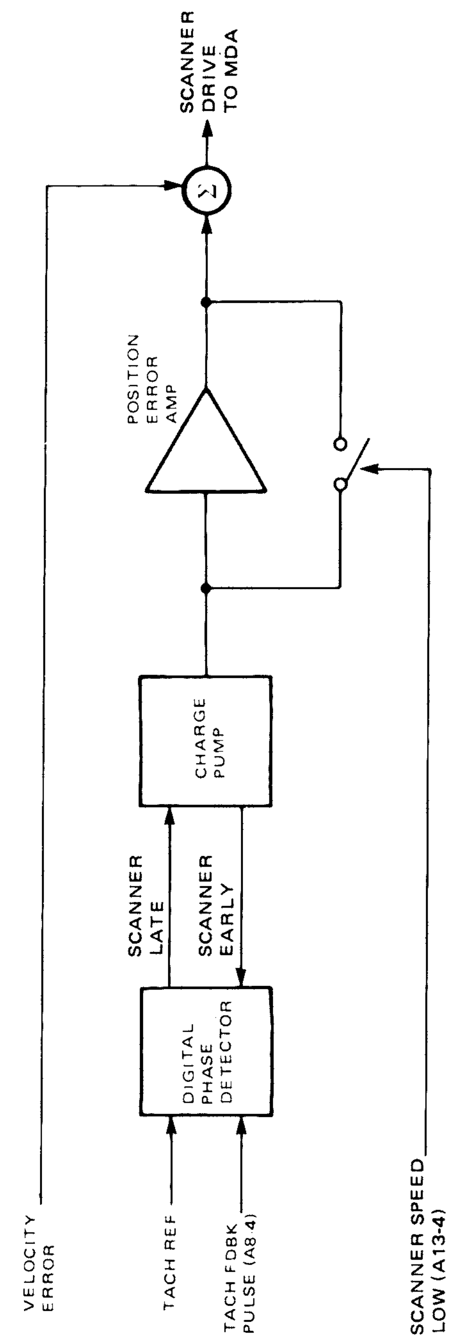


Figure 2-43. Tach Position Servo Block Diagram

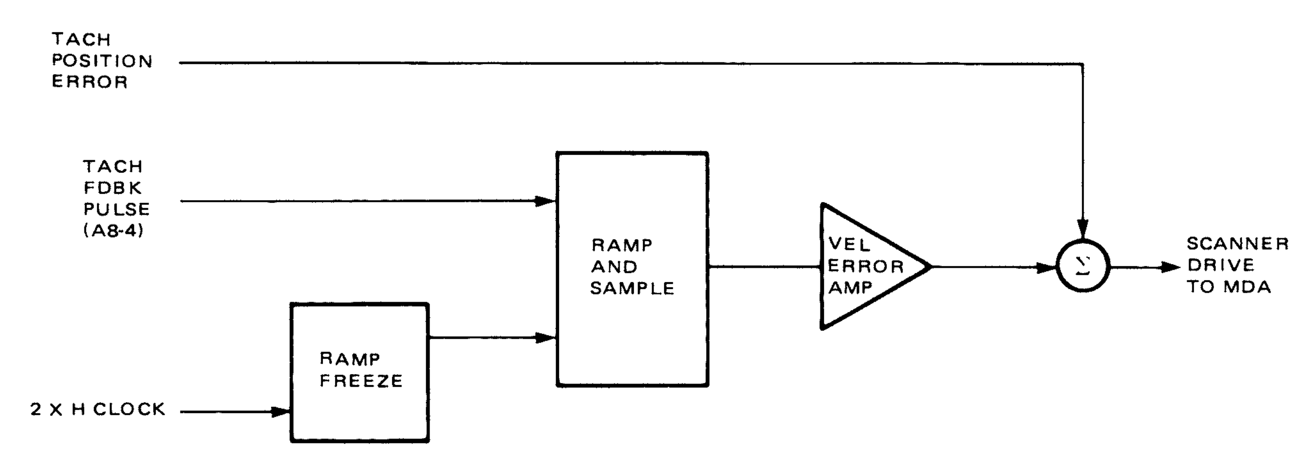


Figure 2-44. Velocity Servo Block Diagram

The SERVO UNLOCKED indicator circuitry (A12-12, A18-6) is driven by a tach position servo signal (A17-3). This signal is a pulse representing the timing error of the scanner, in either direction. If this error exceeds 16 μs, the drum lock detector (A18-6) goes low, turning on the SERVO UNLOCKED LED. Also, when the floating tach reference system is shifting, a signal is routed through shift register (A10) to the servo unlocked circuitry, causing the indicator to light.

2-131. Reference PWA No. 12

This PWA provides sync related referencing signals and all video/sync record and erase commands. Refer to the PWA block diagram, Figure 2-45, and schematic diagram 1400125.

The PWA receives station reference comp sync from the color framer, and receives input video comp sync from the modulator. Based on the operating mode and the setting of a front edge operator switch, the sync select circuit selects one of these sync sources as a reference, for phase-locking a 64 X H oscillator. The 64 X H output is processed to provide 2H and H, as well as audio bias/erase frequencies.

The vertical sync detector provides a reference V pulse for resetting the vertical counter. This reference pulse is also used by a rephase detector, which sends a signal to the control track board when the reference signal changes phase.

The vertical counter drives a scanner reference generator which sends a scanner reference signal to the scanner servo. The scanner reference circuit provides proper TBC lead during normal playback; an associated thumbwheel switch controls the timing of the video output in 1/2 H increments, from zero lead to 7-1/2 H lead.

In addition, the reference board is responsible for providing all video-related record commands to the machine. It receives a video record command from the control board and after comparison with the scanner tach position delivers appropriately timed commands to the video record/erase circuits.

The various functional blocks of the Reference PWA are discussed in the following paragraphs.

2-132. *Sync Select.* Video-in comp sync and external-reference comp sync are applied to retriggerable one shots (A7-5, 13) which detect the presence of sync. Test points are provided at each comp sync input. Gating pulses form the one shots may be switched (A14) to cause selection of one of the input signals.

The switching is determined by a front edge operator switch, S1 (SYNC SELECT, AUTO/EXT/VIDEO). With S1 set at AUTO, the video-in comp sync will be selected in video edit and video record modes, and the external-reference comp sync will be selected in all other operating modes. Regardless of the position of S1, if only one input signal is present, it will be automatically selected. If neither sync signal exists, A13-6 goes low, operating the NON-STD LED and causing the 64 X H phase-lock oscillator to free-wheel.

The sync select switch, S1, can be set to EXT, selecting external reference sync, or to VIDEO, selecting video-in sync, thus overriding the select logic. If the input sync selected via S1 is not the preferred sync for the operating mode of the machine, the NON-STD LED lights.

A selected sync signal is routed to the monitor bridge, the color framer, the phase-lock oscillator, and to a vertical sync detector.

2-133. Vertical Sync Detector. The selected sync is applied to a ramp generator (Q9, R34, C19). Only vertical interval broad pulses allow the ramp to charge to comparator A5 threshold. This first occurs at approximately the middle of the first broad pulse, triggering a one shot (A10-5). The one shot has a pulse duration of about 1/2 field, to inhibit subsequent broad pulses and provide some noise immunity. The leading edge of the one-shot output is pulse shaped and sent to the vertical counter and vertical rephase circuits.

2-134. Phase-Lock Oscillator and Horizontal Counter. Refer to the block diagram of this circuit, Figure 2-46. The main circuitry consists of a ramp generator (Q3-Q6, Q4) a sample and hold circuit (C7, A3, Q2, Q10) an error amplifier (A2), an error pass circuit (Q1, Q8), oscillator (CR2, A1), and horizontal counters. The first three circuits mentioned provide the error signal used by

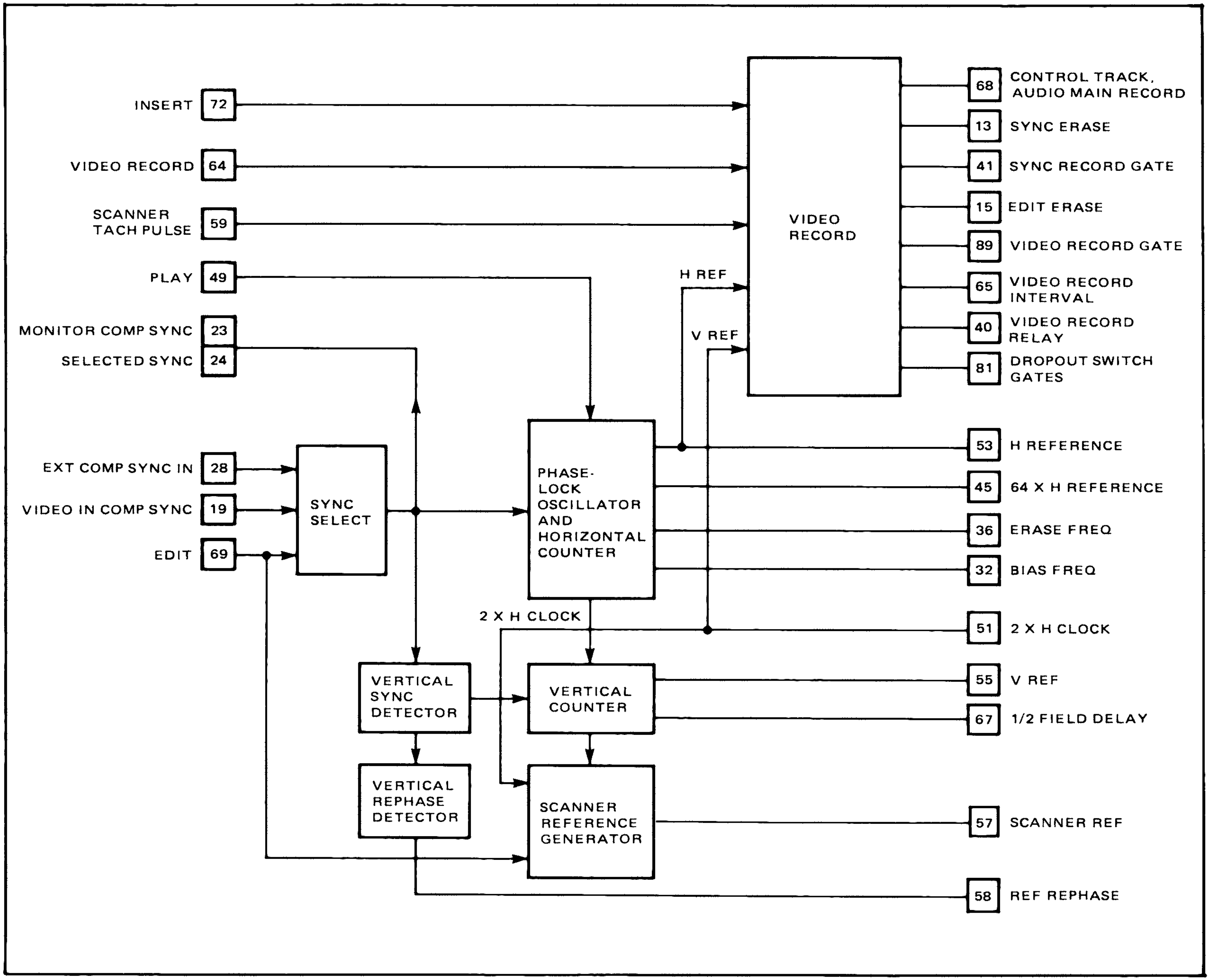


Figure 2-45. Reference PWA Block Diagram

the oscillator when it is in the phase-locked mode. When no comp sync signal is applied to the board, the error pass switch (Q1) is turned off, and the oscillator free-wheels. The resonant frequency of the oscillator is set for 64H (nominally 1 MHz). L1 is adjusted so the oscillator will operate at nominal frequency with the error switch turned off. This can be checked when the system is phase-locked to a reference video signal by observing the error at TP8. It should be 0 ± 0.1 Vdc.

The selected comp sync signal is first passed through a 2H inhibiting one shot (A10). Then it is applied to the ramp generator, turning it off, and simultaneously to the sample and hold circuit, causing sampling of the ramp level. The ramp generator is controlled form a counted-down oscillator output; the sampled ramp level represents oscillator phase error with respect to the comp sync reference signal.

The ramp has a nominal slope of 8 μs. It is nominally initiated 4 μs prior to comp sync. The 2 X H clock output is offset by 4 μs, to agree with comp sync. Adjusting resistor R20 varies the ramp slope, providing a fine phase adjustment. The sampled error is amplified (A2) and, in phase-locked mode, is passed to the oscillator, locking its phase relative to comp sync.

The oscillator output (A1-1) is applied to horizontal counting circuits (A19, A12) to provide H and 2H outputs, as well as the H-rate ramp generator clamp pulse. A 125-kHz bias frequency is generated (A19-9), and is enabled by a play command (also true in record). The oscillator output is also applied to a divider (A18, A21) that provides an 83.3 -kHz erase frequency.

2-135. Vertical Counter. The vertical counter consists of three counters (A26-7, 13 and A34) clocked by the 2 X H clock signal, and associated logic gates. The counter chain is self-resetting, so is capable of free-running at a video vertical rate. The counter is reset by the vertical detector output, keeping the counter in phase with the selected reference input signal.

The most significant bit of the counter chain provides a V reference signal to the rest of the machine. Also, it is used on the reference board to generate a frame reference signal and to drive the scanner reference generator. The counter operates at 50 or 60 Hz, as selected by jumper J5. This jumper selection codes the 50/60 Hz selection bus for use throughout the VPR.

2-136. Vertical Rephase Detector. This circuit consists of latches (A28-5, 9), counter (A34) and associated gates. When a vertical detector pulse occurs (at the first broad pulse), this circuit determines whether the vertical counter is in phase with the pulse. Normally it is, unless the comp sync phase has changed. When this happens the pulse resets the vertical counter, so it matches the new phase of the comp sync reference. Also, a reference rephase signal is sent to the control track and color framer which require this information. This rephase signal is caused to last for eight fields.

2-137. Scanner Reference Generator. This circuit provides a vertical reference signal (SCANNER REF or DRUM REF) to the scanner servo board. In edit and video record modes, the scanner servo positions the head so off-tape vertical sync exactly matches this scanner reference signal. In normal play operation the playback must occur early, to offset TBC time delays. Also, the lead should be adjustable to accommodate a range of TBC types. To meet these requirements, the scanner reference generator uses two time delay networks. These networks are triggered at some time prior to reference V. The maximum delay is assigned for edit and video record modes; lesser delays are generated for playback mode.

The first delay circuit (A9, S2) provides the variable delay associated with the front edge thumbwheel switch, S2 (playback TBC offset select). In normal play mode the counter is loaded with some number from zero to 15 as determined by the setting of S2. The thumbwheel setting (not the count loaded) indicates the lead in 1/2 H units. When released, the counter will count down to zero then provide an output. This output releases the next delay stage and inhibits itself from counting further. The proper delay for edit timing is 15 counts, and is achieved by edit (pin 69) going low, forcing the loading of 15 into the counter regardless of the thumbwheel setting. This provides a lead, for edit mode, of zero.

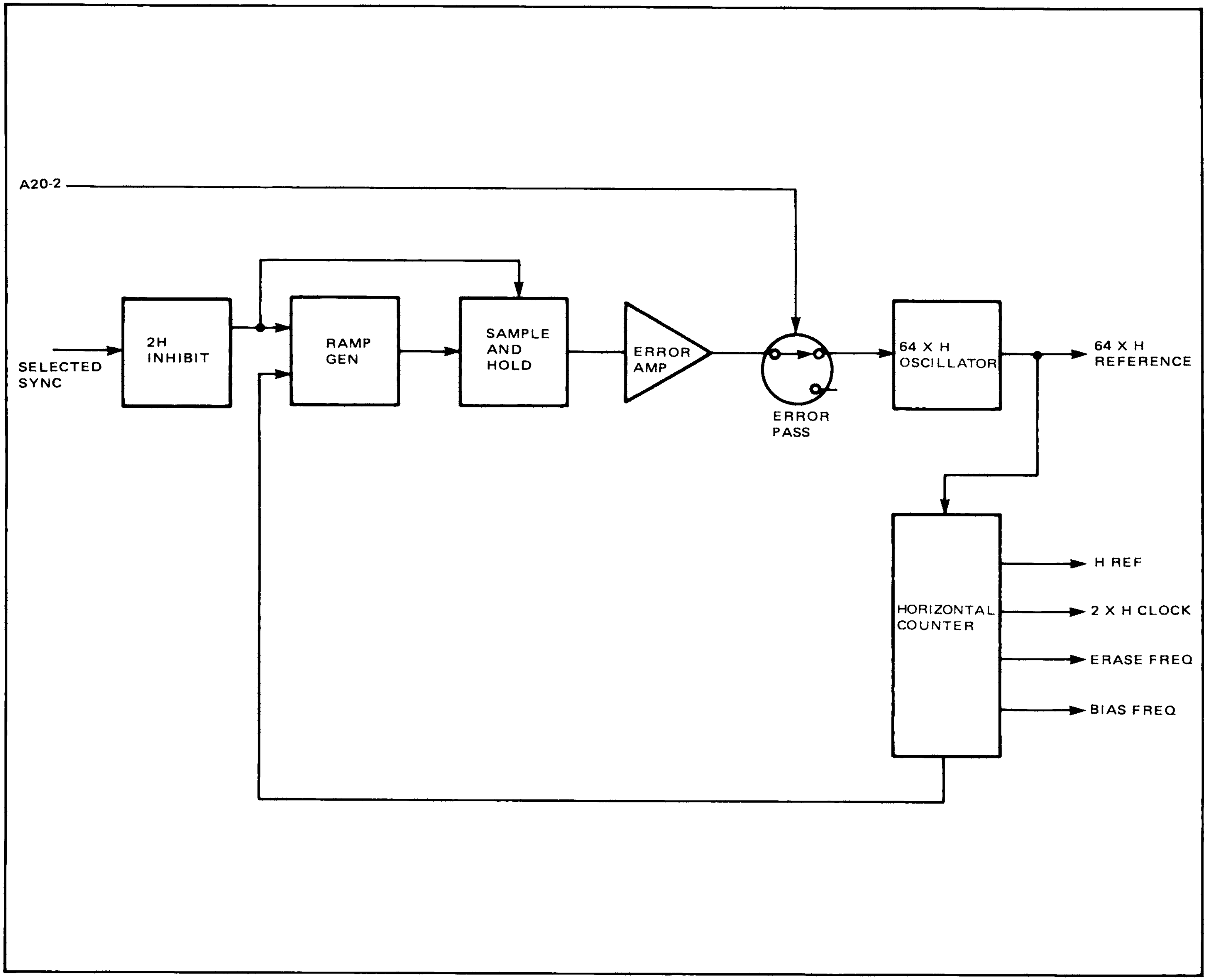


Figure 2-46. Phase-Lock Oscillator and Horizontal Counter Block Diagram

recording positive and negative pulses onto tape. The 125 kHz signal used is the same as that used as bias by the audio system. The record PROM effectively sums the control track pulse and the color framing CFID pulse (developed by Control Track PWA circuitry) recording both onto tape.

Upon power up, the power reset command from the Control PWA is activated clearing the record latch. This ensures that the control track system does not "wake-up" in record mode and arbitrarily record CT pulses onto tape.

2-165. Tracking. Refer to schematic No. 1400142 and to Figure 2-51 (Schematic No. 1400148 and Figure 2-52) while reading the description below.

2-166. *Frame Reference Generator.* With signal H REF applied to its D input, and signal V REF as its clock (both signals from the Reference PWA), the frame reference generator – a type D latch, distinguishes between field 1 and field 2 to produce the frame reference signal. This is a square wave. Thus, a reference frame signal is developed from input video. The reference frame signal produced by the reference frame generator is used by many circuits. It is output (through an inverter) as signal REF FRAME - to the color framer and Time Code Reader/Generator PWA's, and as signal MONITOR FRAME to the MONITOR I/O connector, on the VPR rear panel. It goes to the color frame reference divider where it serves as a clock signal. It goes to the variable tracking circuit to fire the one-shot. The reference frame signal is pulse formed into a narrow pulse and sent as a clock to the phase comparator, and to the unity/variable/self reset logic to serve as the unity frame reference input.

The frame rate counter can operate in any of three different modes: unity, variable, and neither - in which case the counter resets itself in the absence of reference input or during edit record freeze condition. Mode selection is under control of the unity/var/self reset select logic, and the UNITY/VAR switch (PWA front edge).

2-167. *Unity Mode.* Unity mode is effected with the UNITY/VAR switch in the UNITY position. The unity/var/self reset logic selects pulse formed frame reference from the frame reference generator, rejecting that of the variable tracking one-shot. The narrow pulse resets the frame rate counter via select logic. Once cleared, 2H CLOCK (from Reference PWA) begins incrementing the frame rate counter. The counter divides the input clock to produce signals H/2-through-H/12. These divided H counts are supplied to the coarse and fine resolution PROM's which interpret them as gradations of frame time.

The highest order address bit for both PROM's is supplied with signal 50 Hz/60 Hz SELECT – a steady state signal from the Reference PWA. This address bit dedicates PROM operation ot either 50 Hz or 60 Hz operation by selecting only that portion of PROM memory that is suitably programed for the system in use. The next lowest address bit for the coarse resolution PROM receives signal BLINK from the Control PWA. This alternating signal from the Control PWA. This alternating signal effectively divides the half of PROM memory in use – in half again, selecting one-quarter portion or the other according to its high or low state. This action (along with other PROM inputs) produces the narrow on/off LED pulses (PROM output (Q1) fed to the phase comparator. Here, the timing of these pulses relative to the frame reference clock determines the condition of the control panel tracking lamp; on, off, or blinking.

Supplied with these inputs and those from the frame rate counter, the coarse resolution PROM outputs the following signals to the fine resolution PROM (besides on/off LED, described above, field 1/2 (Q2), reset gate (Q3), and CT edge (Q4).

The fine resolution PROM uses these and frame rate counter inputs to produce signals; reset (Q1), chatter inhibit (Q2), CT pulse (Q3), and flag Q4, which are supplied to the latch. The latch "captures" these inputs upon the alternate transition of REF 2H CLOCK and presents them at its outputs as signals self reset, var chatter inhibit, CT edge, and flag respectively.

Signal CT edge clocks the frame rate reference generator which activates signal servo reference – sent to the control track servo. On 525 version boards, CT edge goes to the CT record generator which initiates signal CT record to the CT record

When the record command terminates, the four heads sequence off in the same order. The sync erase head has already finished with the pulse of the previous field, so it turns off immediately.

The sync record latch will complete the record track that is in process and then turn off at the next clock pulse. Likewise, the video erase and video record circuits will turn off at the next clock pulse, thus terminating the record process one field after the record latch is released.

A video record gate is generated by adding the first acknowledged record command to the last one to turn off. This signal is sent to a record switching relay in the scanner and to other VTR servo systems.

2-139. Capstan Servo PWA No. 15. This PWA (see Figure 2-47 and schematic diagram No. 1400155) controls the speed and position of the tape in all record/play modes of operation, including variable speed and all transitional periods between these modes. It operates with the Control Track PWA and the MDA PWA to fulfill this function, and contains three of the four signal generation circuits required to drive the capstan motor. These are the velocity servo, slow motion pulse drive circuitry, and the tach position servo. The fourth circuit, the control track servo, is located on the Control Track PWA. In addition, the Capstan Servo PWA provides control/sequencing logic relating to variable tape speed operation and smooth tape motion transitions during operating mode changes. It also provides local and remote tape speed override (TSO) control capability.

The velocity servo circuit functions in all the above mentioned modes except variable speed below 1/5 normal speed operation. It provides sole control of tape speed in variable operation above 1/5 normal speed, during TSO, and during runup to normal play or record speeds. At (or very near) normal tape speed, the velocity servo functions in parallel with either the tach servo system or the control track servo system to control the capstan.

The pulse drive circuit is only employed with variable speed operation below 1/5 normal speed. This circuit, in conjunction with information from the control system and circuitry on the MDA PWA, will drive the capstan motor in either forward or reverse direction at very slow speeds.

The tach position servo drives the capstan at proper speed during control track record modes of operation, or during playback when the control track signal is missing. Also, it will drive the capstan at a carefully controlled non-standard speed during playback runup to sequence the control track signal into proper position.

The capstan tach signal (from tachometer assembly) is applied via the tach amplifier to the pulse drive, tach position servo, and velocity servo circuits (Figure 2-47 and Schematic No. 1400155). The resulting output from the tach position servo and velocity servo circuits is summed, along with a CT ERROR signal from the Control Track PWA, with the result supplied to the slow pulse select switch. This switch selects either this "summed" drive signal, or the pulse drive signal as the capstan drive signal sent to the MDA. Selection is controlled by a signal pulse drive permit, from the pulse drive permit circuitry, based upon speed information from the velocity servo circuitry. The control logic circuitry provides overall control functions.

2-140. Tach Circuit. The capstan motor has incorporated into it a 60-slot tach disc and a phototransmitter/receiver. Transmitter LED current is supplied by the Capstan Servo PWA (Figure 2-47). The tach signal received from the photocell is applied to the tach amplifier. The amplifier's pulse train output fires two 10-μs one-shots, one of which drives the velocity servo loop, and the other the slow-motion pulse drive circuitry. In addition, the first one-shot's output is divided by 5 for possible use in the position servo, and for use on the Control Track PWA.

2-141. Velocity Servo. Elements of the velocity servo circuit are described below, and are shown in Figure 2-47.

2-142. Speed Detector and Speed Limit Sense. The speed detector is a ramp and sample circuit which detects the period between motor tach pulses (from tach amplifier) to determine capstan speed. Capacitor C18 is allowed to charge positively during the period between capstan tach

pulses. The level of charge is sampled by A4 and stored by C5 at the ramp's positive peak. A1 buffers C5. The buffer output is a speed sense signal which goes to speed sense comparators, and (through processing) to the velocity error amp and another speed limit sense comparator. Comparators A8-12 and A8-13 compare this signal with voltage thresholds to sense when the capstan is within ±7% of play speed. The outcome is sent to control logic.

The trailing edge of the tach pulse resets (via tach amplifier) the speed detector circuit, enabling another sample to commence. The greater the period between tach pulses, the more positive the speed sense signal developed.

Comparator A8 detects when the capstan is operating below 1/5 normal speed. When this condition occurs, and a variable signal is true, then slow motion pulse drive operation is established.

2-143. Velocity Error Amp. The input to the velocity error amp constitutes a summing point — the components of which are: actual capstan speed information from the speed detector; speed program voltage (of opposite polarity) from speed program generator, and; when in tape speed override (TSO) mode, TSO voltage from the locator remote panel. The velocity error amp produces a velocity error signal from this summed input voltage. The amplified error signal is used to control the speed of the capstan motor. During normal speed playback, the amplifier output is summed with a control track error signal (from Control Track PWA). The slow pulse select switch selects the resultant voltage to drive the capstan, except when pulse drive permit is in force.

When the VTR is not using the capstan, as in stop or shuttle modes, the velocity error amp is switched off (signal play inactive). When entering play or record modes, the speed program generator provides a signal to the summing point which ramps slowly to a reference level representing desired motor speed. Tape speed thereby starts slowly, accelerating to play speed period in about 1/2 second.

2-144. *Speed Program Generator.* During normal play, capstan speed is determined by play speed reference from a resistor-divider network. During variable speed operation, signal capstan variable becomes true. This signal, by means of two switches of the speed program generator, selects different voltages to be supplied to the amplifier.

One voltage is slow speed control, which is controlled by the position of the shuttle knob on the control panel. The other is +5V reference with which signal slow speed control is compared. The amplifier output is summed with that of the speed detector to control capstan speed according to the position of the shuttle knob. The variable speed limit set potentiometer (R24) is set to limit the maximum capstan speed in variable mode. At speeds below 1/5 play speed, signal pulse drive permit becomes active, causing the slow-pulse select switch to substitute the pulse drive signal for that from the velocity error amp.

2-145. *TSO Operation.* During TSO operation, a TSO component (either remote or local) is added to the velocity error summing junction. If capstan control logic acknowledges TSO request by issuing TSO command, TSO control voltage is connected to the summing junction. TSO operation is only allowed when the speed program generator is operating at standard operating speed. The input to the summing junction from the speed program generator is (at this time) fixed since it is based upon the play speed reference. The voltage of the TSO signal received is allowed to alter capstan speed within limits. The range for TSO is limited to ±15%.

2-146. *Pulse Drive System.* This system drives the capstan motor only when: (1) the VTR is in variable mode, and (2) capstan speed is below 1/5 normal play speed. A comparator of the speed limit sense circuit monitors processed speed sense signal from the speed detector. When this analog voltage drops to a certain value with respect to play speed reference, the comparator output toggles, signaling the pulse drive permit logic to enable pulse drive.

The pulse drive generator consists of a tach counter, a variable interval monostable, and a NAND gate. The time out interval of monostable A2-5 is controlled by signal PULSE CTL, which originates with the slow motion/shuttle control (front panel).

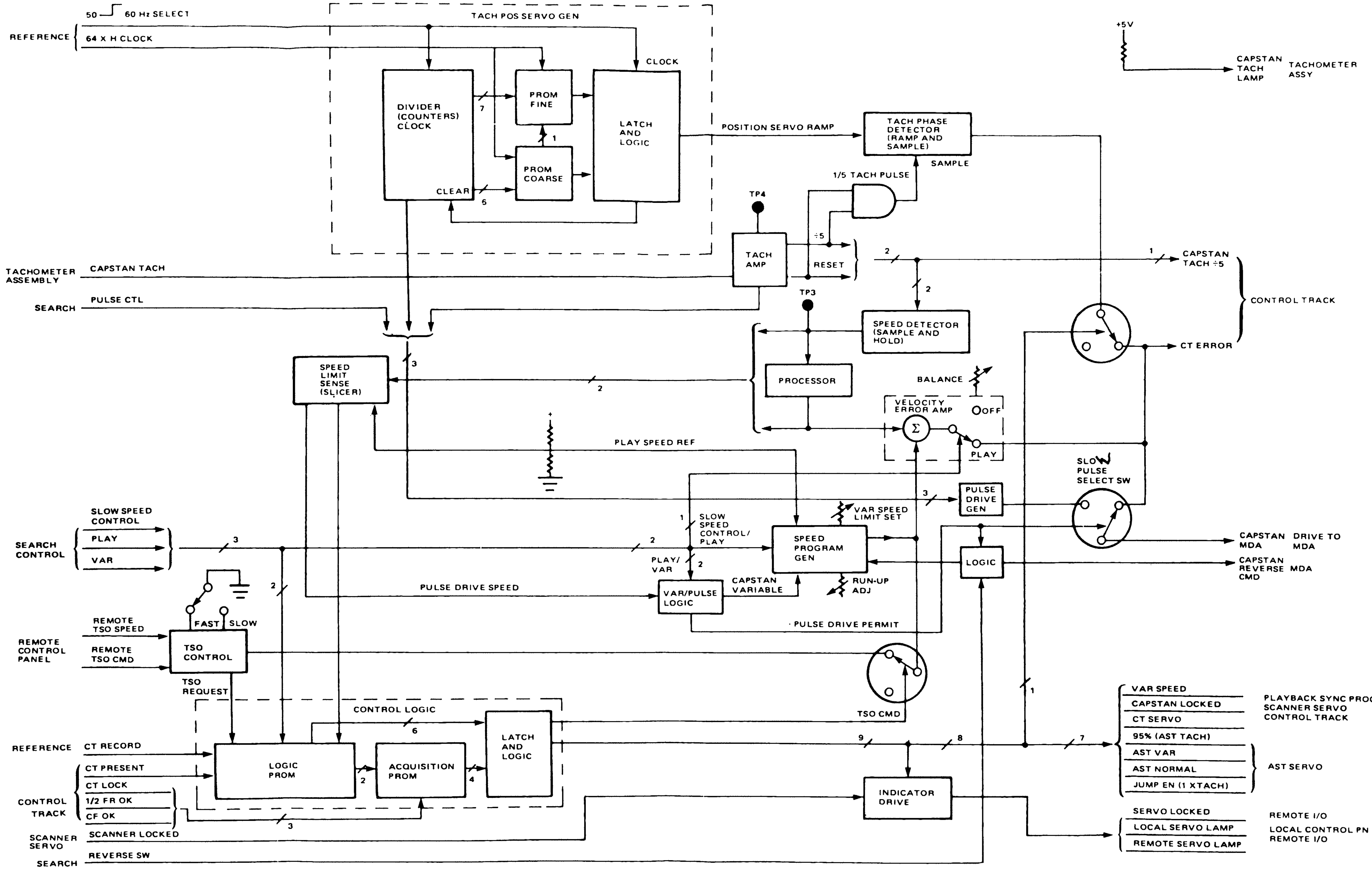


Figure 2-47. Capstan Servo PWA

Turning the SHUTTLE control CW causes the conductance of transitor Q1 (monostable time out circuit) to increase, decreasing monostable time out period. Conversely, turning the slow motion/ shuttle control CCW causes Q1 to conduct less, increasing the time out period. This action controls pulse drive frequency in the manner described below.

The 64 X H CLOCK signal is divided down by counters A31, A30, and A13-5 to produce capstan drive pulses of fixed pulse width at NAND gate output A9-1. This is allowed while monostable A2-5 is inactive. Upon every other capstan tach pulse, however, tach divider A13-5 fires the monostable.

The active monostable output disarms the NAND gate, and clears clock divider A13-2, inhibiting capstan drive pulses during time out interval. Thus, the duration of monostable time out interval controls the frequency of capstan drive pulses, and thereby capstan speed. Slow pulse select switch selects pulse drive (signal pulse drive permit-true) allowing the drive pulses to pass directly to the capstan drive circuit of the MDA.

The REV position of the slow motion/shuttle control commands the pulse drive system (through the Search PWA) to move the tape in the reverse direction. Simultaneously, capstan reverse command is sent to the MDA Assembly. This signal switches a solid state relay, providing reverse capstan motor current by switching motor leads.

2-147. *Tach Position Servo.* This circuit serves to operate the capstan at a precisely controlled speed. It is used: during record modes of operation; during playback if the control track signal is missing; and during lockup sequencing of the control track system in playback. By locking the capstan tach to a known reference frequency, the motor will operate at exactly the speed denoted by the reference frequency. The tach position servo operates at 1/5 the rate of the tach, or about 360 Hz.

The reference frequency is derived from reference 64 X H clock by the tach position reference generator (Figure 2-47). This circuit consists of a divider (three stages) and two PROM's. PROM outputs are clocked into latches by 64H clock. Signal 50/60 Hz tailors PROM operation (and thereby capstan servo operation) to the system in which it is used. PROM programming is such that the frequency produced conforms to the desired speed of the capstan motor. The fine PROM resets the divider. The coarse PROM operates the ramp and sample circuit of the tach phase detector. During normal playback, when the control track servo is operating and the tach position servo is not, the tach divided by five resets the divider. This is done so that, when the tach position servo is going to be used, there will be a known phase relationship between the frequency reference and the tach feedback. This action prevents the servo from starting with a large error.

The fine PROM's output is the same as the reference frequency (from coarse PROM) but is offset in phase. This signal along with 1/5 tach phase is processed by the ramp and sample of the tach phase detector to produce a signal accurately representing tach phase error. The ramp commences through a current source (resistor) which is then sampled when signal 1/5 tach pulse occurs. The ramp is reset by signal position servo ramp when true. The sample is held and applied to an amplifier which has a compensation network for servo phase correction. The resulting tach phase error signal may be selected by a switch (under control of signal tach servo command) to be summed with the velocity error signal which (together) comprise the drive signal to the capstan MDA.

2-148. *Motor Drive Sum.* The outputs of the velocity servo, the tach position servo and the control track servo are added together to appear at one input of the slow pulse select switch, (the other input being the pulse drive signal). Of the three, only the control track error signal is always present (when the control track error amp is not in use, its output assumes a nominal value). It is the interaction among the outputs of these three circuits which results in proper overall operation.

The capstan motor must receive the proper dc bias to allow the servos to operate at their nominal settings, and within their limited range.

Like the scanner servo, the control track position loop will assume whatever dc level it must in order

to reduce the CT position error to zero. However, the circuit can only operate within a limited dc range. Therefore, balance control R1 exists to provide an adjustable dc bias from the velocity error amplifier. It is adjusted to center the CT servo in its range. The tach position servo contributes some dc bias when operating, but none when disconnected. To compensate for this absent bias, transistor Q4 is turned on (signal tach servo command not true) when the tach position servo is turned off. This action introduces dc drive to simulate the center position of the tach position servo.

2-149. *Control Logic.* Control logic for the Capstan Servo PWA consists of two PROM's with associated latches and gating. The circuitry's job is to control capstan motor servo drive circuit operation. In doing so it must: acquire the correct field when play mode is initiated; sequence the AST system through its different modes of operation; and notify the Scanner Servo and Playback Sync Processor PWA's when the machine is in variable speed operation.

The important task of acquiring the correct field, then switching to control track operation is primarily performed by the acquisition PROM, and is done in three stages.

First, the velocity servo ramps the capstan to ± 7% of normal play speed. Next, the tach position servo acquires the correct field, the capstan speed running at 95% to achieve this. Finally, control track operation is initiated. These three steps occur as follows:

1. Run-up. The play command is received from the Control PWA. The velocity servo initiates ramp-up of capstan speed, approaching normal play level. Commands are sent to the AST servo and scanner servo boards, placing them in variable mode. The speed limit sense signal to the logic PROM (A15) is activated when capstan speed is within 7% of normal play speed.

2. Color frame lock. The tach position servo is activated at slip speed (95%), which is maintained by a control logic command (slip bus) to the coarse PROM (A24) of the tach position reference generator. The 95% (AST tach) signal is sent to the AST servo, placing it in the acquisition mode. The capstan locked signal maintains the scanner servo in variable mode. The acquisition PROM (A32) is enabled, and waits for correct conditions for color frame locking. Slip speed continues until the 1/2 frame OK, and color frame OK signals (from the Control Track PWA) indicate that the control track signal is centered on the correct field. Then, the slip speed signal to the coarse PROM (A24) is removed. This allows the tach position servo to increase capstan speed to 100%, locking onto the correct field, and also triggers a one-shot (A16-13) that provides a delay for servo settling (before control track lock is switched in). The AST servo system is still in acquisition mode and the scanner is still in variable, until the one-shot times out.

3. Control Track Operation. The one-shot delay ends, and a CT servo signal is sent to the Control Track PWA, turning on the control track servo error. The tach position servo is turned off. The AST servo and scanner servo circuits assume normal mode operation, in response to the AST normal and capstan locked signals, respectively.

TSO is permitted only in normal playback operation. When it is turned off, the capstan always returns to a lower-than-normal play speed. The capstan then repeats the control track lockup sequence.

The control logic also determines if the capstan is operating normally. It will light the PWA edge mounted SERVO UNLOCKED indicator (LED) if a fault is detected. A parallel path lights the control panel SERVO indicator via indicator drive Q3. (The SERVO indicator is also activated with the occurence of a scanner servo fault.)

2-150. Control Track PWA No. 14.

This PWA contains all circuitry required to operate the control track head for both record and playback operations. The color frame identification signal (CFID) used for color framing is generated and recorded by Control Track PWA circuitry working with the control track head.

norm/invert switch of the Color Framer PWA. When switched, it inverts the action of signal CF OK to the Capstan Servo.

2-179. Color Framer PWA No. 13. This PWA accomplishes four functions for the VPR. The color framer provides:

1. Composite sync to the Reference PWA – developed by the color framers reference video sync stripper circuit.

2. A 7.8-kHz reference to the control track servo system – used to provide the VTR with a 15-Hz (12-1/2-Hz) (1/2-frame rate) master reference. This master reference is required in PAL, PAL-M, and SECAM systems for correct color video operation during record and playback.

3. A 1/4-frame rate reference signal to the control track servo system – used on PAL and PAL-M systems to provide color frame referencing.

4. Local operator controls, and remotely sourced operator controls. These PWA front edge controls (along with above named reference signals) allow identification and phase control over color frame/sync sequences. This action allows horizontal picture shift – which could accompany edits – to be minimized. Such shifts result from edits in which the VTR does not lock vertically to the proper color frame sequence of the input signal. Color detection is also provided, shutting down the system in the presence of monochorma signals.

2-180. *Color Framing and TBC's.* Most contemtime-base correctors (TBC's) operate similarly. They create a framework of composite sync and color burst and modulate the timing of the input video signal to place it within this frameowrk. The modulation process consists of three basic steps:

1. The vertical sync of the input video signal is compared to the reference vertical sync to determine where the horizontal lines of the signal should be placed in the resulting raster. This step is a very coarse adjustment called "vertical centering."

2. The horizontal sync of ~~the input~~ video signal is compared to horizontal reference sync and the signal is shifted left or right in time to fit within the finished framework.

3. After horizontal sync positioning, the color burst is compared to the reference subcarrier burst, and the signal is further shifted left or right to match the phase of the reference subcarrier.

In NTSC systems, the video color burst. relative to horizontal sync, reverses phase every line, and the same line on two consecutive frames exhibits a reversed burst phase. Regardless of which phase is presented to the TBC, the TBC shifts the signal to make the phase match and reference phase. This means the TBC can accept any given signal and position it in the framework of sync and burst. When the same signal of the opposite frame is presented, it is shifted left or right of the original signal by 1/2 cycle of burst.

Current NTSC specifications define the frequency and sequence relationship between video sync and color burst but do not define the absolute phase relationship between them. Unless the input reference to the TBC is in exact agreement with the references that created the original video signal, the TBC always shifts the picture content slightly from the original. This shift is random and can be up to a magnitude of ± 1/2 cycle of subcarrier. The color framing system limits this shift to ± 1/4 cycle of subcarrier.

This shift can be seen in two ways:

1. Video horizontal blanking is widened. The TBC inserts new blanking over the original blanking. When there is a shift, the total blanking width is modulated and can only become wider.

2. The picture or scene content visibly jumps sideways as a result of switcher action or an edit in the videotape. In most cases, this jump is not objectionable as the change in scene content usually provides little reason to notice the shift. However, where like picture content is being edited, the jump can be objectionable.

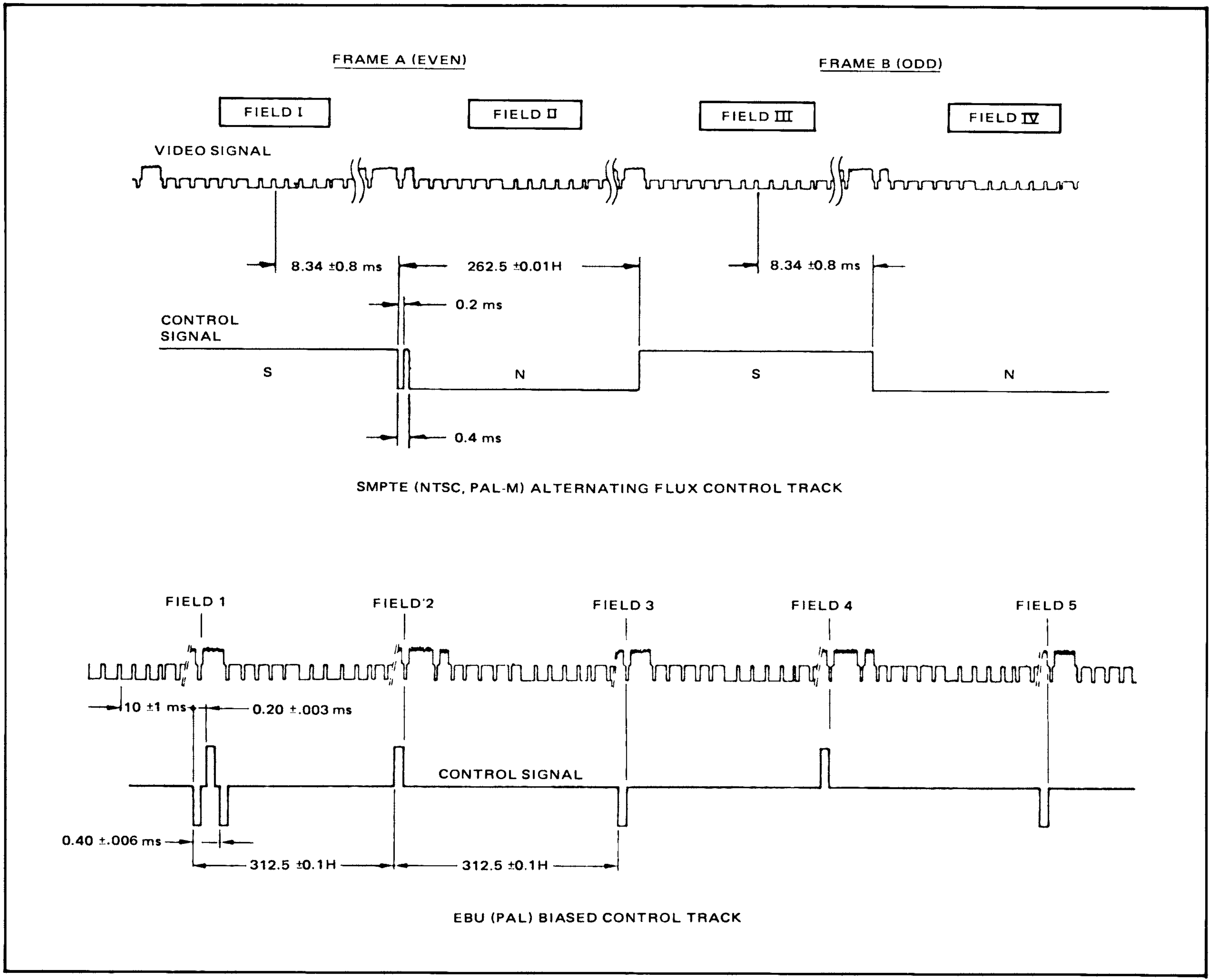


Figure 2-48. Control Track Waveforms and Timing

the oscillator when it is in the phase-locked mode. When no comp sync signal is applied to the board, the error pass switch (Q1) is turned off, and the oscillator free-wheels. The resonant frequency of the oscillator is set for 64H (nominally 1 MHz). L1 is adjusted so the oscillator will operate at nominal frequency with the error switch turned off. This can be checked when the system is phase-locked to a reference video signal by observing the error at TP8. It should be 0 ±0.1 Vdc.

The selected comp sync signal is first passed through a 2H inhibiting one shot (A10). Then it is applied to the ramp generator, turning it off, and simultaneously to the sample and hold circuit, causing sampling of the ramp level. The ramp generator is controlled form a counted-down oscillator output; the sampled ramp level represents oscillator phase error with respect to the comp sync reference signal.

The ramp has a nominal slope of 8 μs. It is nominally initiated 4 μs prior to comp sync. The 2 X H clock output is offset by 4 μs, to agree with comp sync. Adjusting resistor R20 varies the ramp slope, providing a fine phase adjustment. The sampled error is amplified (A2) and, in phase-locked mode, is passed to the oscillator, locking its phase relative to comp sync.

The oscillator output (A1-1) is applied to horizontal counting circuits (A19, A12) to provide H and 2H outputs, as well as the H-rate ramp generator clamp pulse. A 125-kHz bias frequency is generated (A19-9), and is enabled by a play command (also true in record). The oscillator output is also applied to a divider (A18, A21) that provides an 83.3 -kHz erase frequency.

2-135. Vertical Counter. The vertical counter consists of three counters (A26-7, 13 and A34) clocked by the 2 X H clock signal, and associated logic gates. The counter chain is self-resetting, so is capable of free-running at a video vertical rate. The counter is reset by the vertical detector output, keeping the counter in phase with the selected reference input signal.

The most significant bit of the counter chain provides a V reference signal to the rest of the machine. Also, it is used on the reference board to generate a frame reference signal and to drive the scanner reference generator. The counter operates at 50 or 60 Hz, as selected by jumper J5. This jumper selection codes the 50/60 Hz selection bus for use throughout the VPR.

2-136. Vertical Rephase Detector. This circuit consists of latches (A28-5, 9), counter (A34) and associated gates. When a vertical detector pulse occurs (at the first broad pulse), this circuit determines whether the vertical counter is in phase with the pulse. Normally it is, unless the comp sync phase has changed. When this happens the pulse resets the vertical counter, so it matches the new phase of the comp sync reference. Also, a reference rephase signal is sent to the control track and color framer which require this information. This rephase signal is caused to last for eight fields.

2-137. Scanner Reference Generator. This circuit provides a vertical reference signal (SCANNER REF or DRUM REF) to the scanner servo board. In edit and video record modes, the scanner servo positions the head so off-tape vertical sync exactly matches this scanner reference signal. In normal play operation the playback must occur early, to offset TBC time delays. Also, the lead should be adjustable to accommodate a range of TBC types. To meet these requirements, the scanner reference generator uses two time delay networks. These networks are triggered at some time prior to reference V. The maximum delay is assigned for edit and video record modes; lesser delays are generated for playback mode.

The first delay circuit (A9, S2) provides the variable delay associated with the front edge thumbwheel switch, S2 (playback TBC offset select). In normal play mode the counter is loaded with some number from zero to 15 as determined by the setting of S2. The thumbwheel setting (not the count loaded) indicates the lead in 1/2 H units. When released, the counter will count down to zero then provide an output. This output releases the next delay stage and inhibits itself from counting further. The proper delay for edit timing is 15 counts, and is achieved by edit (pin 69) going low, forcing the loading of 15 into the counter regardless of the thumbwheel setting. This provides a lead, for edit mode, of zero.

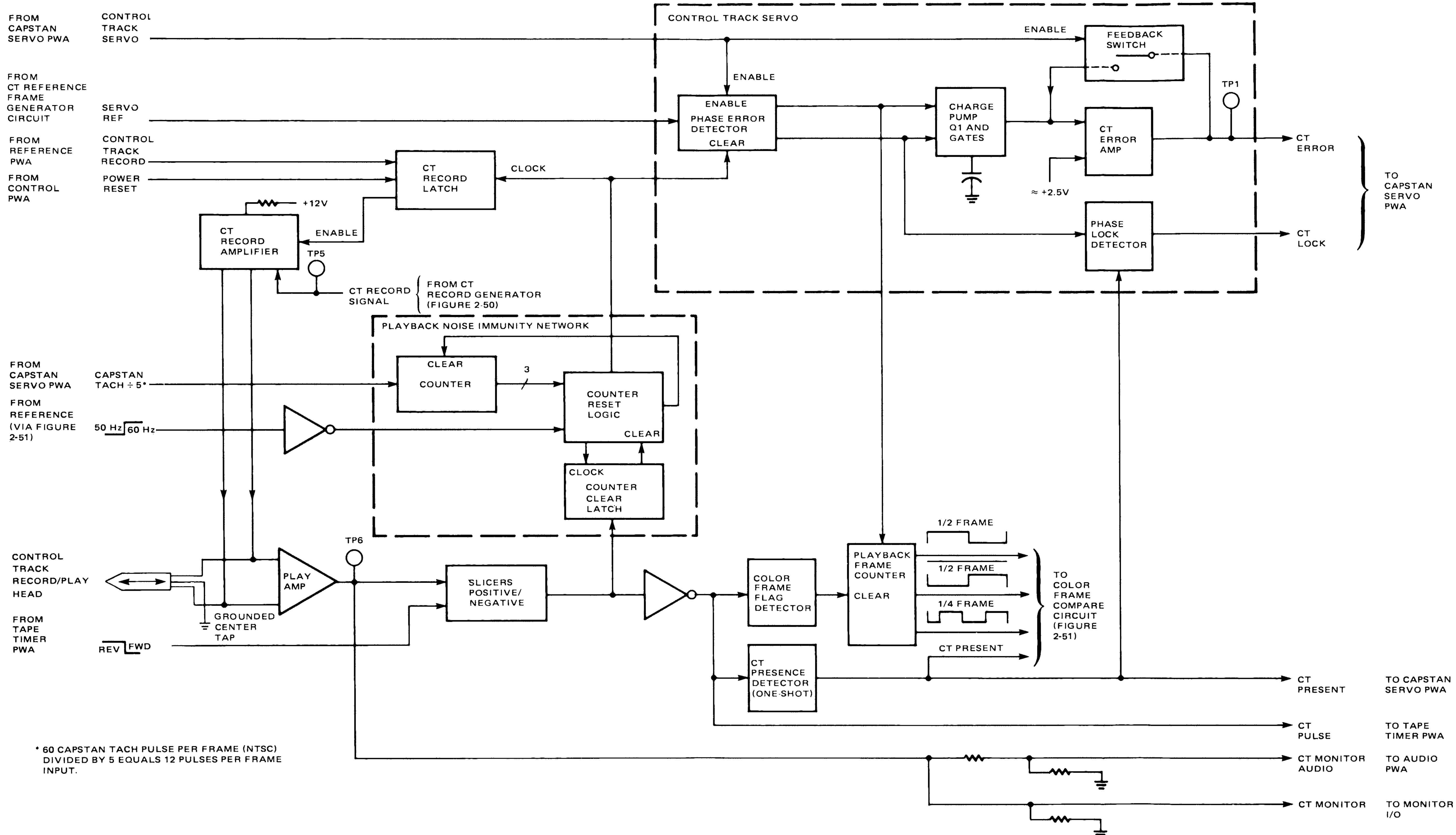


Figure 2-49. Control Track (525) PWA Playback Servo Record Output Circuits

time frame. This effectively excludes noise pulses which occur outside of this time frame.

2-157. *Control Track Servo.* Circuitry for the control track servo is similar to that of the scanner servo. The control track servo has a zero-error phase detector possessing a limited dynamic range. It must be centered.

Enabling of the control track servo system is accomplished by signal CT servo command, from the Capstan Servo PWA. When the capstan motor rotation is outside of the dynamic range of the control track servo system (as during run-up), CT servo command is not in force, disabling CT servo. The feedback switch (two transitors) is open, withholding the feedback loop for the error amplifier. The error amplifier output nominalizes at about the reference voltage present at one of its inputs (+2.5V). This voltage (signal CT error) is output to the Capstan Servo PWA, which defines the middle of the servo range and may be observed (when the servo is not working) at front edge test point TP1. Once capstan speed is within dynamic range, CT servo command is forced enabling the phase error detector and the feedback switch, thereby making the amplifier operative.

The phase error detector compares the timing between the precision servo reference signal (from the CT reference frame generator) and processed CT pulses from the control track record/play head. The greater the timing disparity between the two signals, the greater amount of time the charge pump transistor is turned on. (Note: the charge pump circuit is used only on the 525 system. For a 625 system, a ramp-and-sample circuit is used instead.) The transistor charges up a capacitor and the resulting integrated voltage is applied to the error amplifier.

If the control track pulses run ahead of the servo reference signal, indicating the capstan is running too fast, the charge placed on the charge pump capacitor is greater, and the resulting voltage out of the error amplifier diminishes – tending (ultimately) to slow the capstan. If the control track pulses lag the servo reference signal (capstan too slow), the inverse applies and the voltage out increases tending to speed up the capstan. The error amplifier output range runs from slightly less than +1V to just greater than +4V, operating around a nominal +2.5V. The phase lock detector monitors the output of the phase error detector by means of an exclusive OR gate. Any disparity between the gate two inputs results in a one-shot being fired (by XOR gate output) with a latch monitoring the outcome. If the disparity still exists at the end of one-shot time out, the latch "captures" the event and outputs it as CT lock command, to the Capstan Servo PWA. Mistiming of this magnitude thereby denotes that the control track servo is not locked.

If the CT presence detector fails to detect control track, it retires CT present command, disabling the phase lock detector, causing it to rescind CT lock command.

2-158. Playback CT Pulse Processing – 625 System. Refer to Figure 2-50 and to Schematic No. 1400148 while reading the following description. Figure 2-49 is a general control track waveform timing diagram, and is provided for reference:

Feedback for the control track system comes ultimately from the control track record/playback head. The low level control track signal is amplified by the 2-stage play amplifier (Figure 2-50). The PLAY CAL potentiometer (output of play amp) is adjusted to calibrate playback level as monitored at TP2. A standard control track calibration tape is required for this process.

The calibrated playback signal is supplied to one input of the P/B summing amplifier. The other input of the P/B summing amplifier receives a cancellation signal from the cancellation amplifier. This signal is derived rom EBU Audio 4 and Audio 3 cancellation signals – from the EBU Audio and Audio PWA's respectively. The EBU and A3 cancellation potentiometers, and the phase adjust potentiometer, are calibrated for minimum audio crosstalk into the control track channel, as observed at TP2.

The frequency compensation switch changes feedback frequency compensation for the summing amplifier whenever play mode is abandoned (PLAY command rescinded). This action increases amplifier sensitivity during varying shuttle speeds which may go as high as 300 in/sec. Thus, the

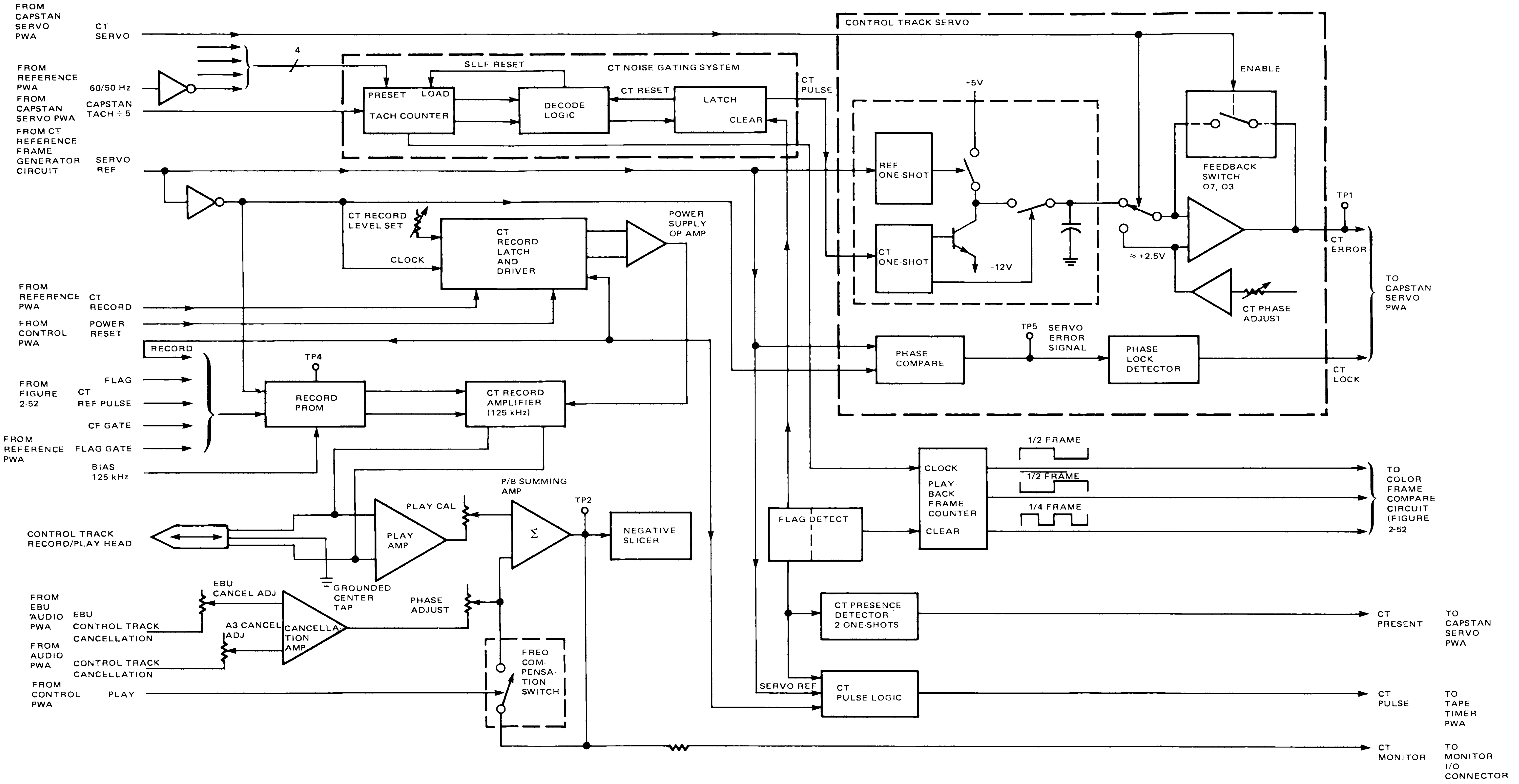


Figure 2-50. Control Track (625) PWA Playback, Servo, and Record Output Circuits

certainty of playing back the narrow EBU CT pulses is greatly enhanced throughout the tape speed range.

The analog pulse train out of the summing amplifier goes to the slicer, and is output (in buffered form) as signal CT monitor to the monitor I/O connector on the VPR rear panel. In the EBU biased control track system, the field 1 pulse recorded negatively (forward direction) plays back as a negative pulse in either forward or reverse direction. Thus, a negative slicer only is required (NTSC control track requires a positive slicer as well to accommodate reverse motion).

2-159. Color Frame Processing. The slicer output fires the input stage of the flag detector circuit – a one-shot. This stage outputs a broad well-defined TTL level CT pulse to CT pulse logic, CT presence detector, and to the CT noise gating system. The CT pulse logic outputs CT pulse signal to the Tape Timer PWA (to increment/decrement tape timer) provided CT record is not in force. The CT presence detector (2 one-shots) monitors the period of the playback CT pulse train. If it is within an acceptable window, CT PRESENT command is asserted to the Capstan Servo PWA.

The second stage of the flag detect circuit "looks" for the playback CFID color framing pulse immediately after the CT pulse. When detected, it clears the playback frame counter – initializing the 1/2-frame/1/4-frame count down. The playback frame counter resumes counting upon the next clock pulse from the CT noise gating circuit. Its 1/2-frame/1/4-frame outputs go to the color frame compare circuit of this PWA. Here, these signals are used to determine which field of the color framing sequence is in force.

2-160. CT Noise Gating System. Since digital phase detectors interpret missing or extra pulses as a 360-degree error, a noise immunity circuit is required. The CT noise gating system is a variable width monostable and a counter operated by the tape tach signal, and reset by the control track signal. Its functions are to clock the playback frame counter, clear the phase compare latch, and fire the CT one-shot – part of the control track servo. This it must do (1) for legitimate CT pulses, (2) when a CT pulse is missing, or (3) (inversely) it must inhibit extra or spurious pulses when they occur – allowing only one to prevail. The process begins when the tach counter (of the CT noise gating system) is loaded. The counter loads a hardwired 4-bit number.

The counter increments – clocked by signal capstan tach from the Capstan Servo PWA. Upon reaching the proper count, the decode logic clocks the latch – arming it to respond to the playback CT pulse. If the playback CT pulse arrives within the alloted window, the latch is cleared, loading the tach counter (via decode logic) renewing the process. If playback CT pulse does not arrive within the allotted window, the decode logic (after a few more incrementations of the counter) self resets loading the counter anew. With respect to signals sent to the control track servo circuit, the outcome is of two different types, depending on whether normal CT reset, or self reset occurs.

2-161. *Control Track Servo.* The CT servo circuit has two modes of opertion, determined by the state of CT SERVO command from the Capstan Servo PWA. During run-up, or when tape speed is outside of the allowed play window, CT SERVO command is withheld, shutting down the CT servo. CMOS switches short out the inputs to the CT error amplifier, and an FET transistor switch opens its feedback circuit. These actions freeze the amplifier's output at a nominal value of about +2.5V (this value is set by the CT phase adjust potentiometer).

When the capstan is at or near play speed, CT SERVO command is asserted, enabling the CT servo circuit. The CT error amplifier's feedback circuit is closed, and CMOS switches supply CT error voltage from the ramp-and sample to its input. The error voltage present across the ramp-and-sample capacitor results from the timing relationship between the servo reference signal, and the CT pulse (which could be absent).

The reference one-shot is fired by signal servo reference – when it occurs. The one-shot closes the CMOS switch – coupling +5V to the error capacitor. When CT pulse occurs, it couples the accumulated sample to an integrating capacitor. The voltage across this integrating capacitor is supplied to the error input of the CT error

amplifier (through a buffer amp – not shown). The CT one-shot, when active, shuts off bleeder transistor Q1 ensuring that a stable sample is given to the integrating capacitor. When the CT one-shot times out, Q1 turn on, bleeding the charge from the error capacitor.

The more the CT pulse signal lags the servo reference signal (tape running slow), the greater the positive charge accumulated across the error capacitor and (eventually) supplied to the error amplifier. Inversely, the shorter the lead (tape running fast) the less charge develops across the error capacitor – the less positive the voltage supplied to the error amplifier. The resulting error amplifier output influences capstan rotation (via Capstan Servo PWA) causing it to advance or retard the tape with respect to the video head as appropriate. The CT phase adjust potentiometer establishes control track phase by varying the reference voltage supplied to the error amplifier. The error amplifier's output range goes from slightly less than +1V to just over +4V, operating around a nominal +2.5V.

2-162. Phase Comparator and Lock Detector. These two circuits work together to monitor the phase relationship between servo reference and CT pulse. The resulting CT LOCK signal supplied to the Capstan Servo PWA denotes whether the phase disparity (between the two signals) is within or without the allowable amount.

The phase comparator latch is clocked by servo reference (inverted), and cleared by reset from the CT noise gating circuit (which results from CT pulse). An exclusive OR gate compares the resulting latch output with servo reference. Any timing deviations activate the gate's output to the phase lock detector, comprised of a one-shot and a latch. The one-shot fires, supplying a window to the D input of the latch. If the latch is clocked by the exclusive OR gate within this window time, CT LOCK command remains in force, indicating that phase deviation is within servo limits. If the exclusive OR gate clocks the latch after expiration of a one-shot time out, the latch interprets this as a "not-locked" condition, and rescinds CT LOCK command.

2-163. Record Mode – 525 System. The output portion of control track record circuitry is shown in Figure 2-49. Record mode is readied when the Reference PWA asserts CT record command to the CT record latch. The next CT pulse from the CT record/play head (via processing circuits) clocks the record latch, latching record mode. The CT record amplifier is both enabled and turned on by the record latch. The CT record amplifier experiences a soft turn on. Once turned on, the amplifier passes and amplifies the square wave CT input signal (from the control track record generator) by alternately supplying +12V to each of its output lines. The output lines alternately drive each winding of the center tapped record/play head, recording a bipolar square wave on tape.

Upon system power up, the power reset command from the Control PWA is activated clearing the record latch. This is done to ensure that the control track system does not "wake up" in the record mode and arbitrarily record CT pulses onto tape.

2-164. Record Mode – 625 System. The output portion of control track record circuitry is shown in Figure 2-50. Record mode is readied when the Reference PWA asserts CT record command to the CT record latch. The next positive transition of the servo reference signal (from inverter) clocks the latch – latching record mode. The record latch output informs the record PROM that record mode is in force, and supplies a soft turn on of the CT record amplifier via driver transistor and power supply op-amp. The CT record level set potentiometer controls the supply voltage provided the CT record amplifier, and thereby the record output amplitude. CT record latch output also switches the CT pulse logic, causing it to select servo reference (over playback CT pulse) as the CT pulse signal sent to the Tape Timer PWA.

With the input signal "record" asserted, the record PROM operates the two transistors of the CT record amplifier in "switching drive" fashion It supplies the basic 125-kHz bias signal (from the Reference PWA) to first one, then the other output transistor. This action alternately drives each leg of the record head winding – thereby

recording positive and negative pulses onto tape. The 125 kHz signal used is the same as that used as bias by the audio system. The record PROM effectively sums the control track pulse and the color framing CFID pulse (developed by Control Track PWA circuitry) recording both onto tape.

Upon power up, the power reset command from the Control PWA is activated clearing the record latch. This ensures that the control track system does not "wake-up" in record mode and arbitrarily record CT pulses onto tape.

2-165. Tracking. Refer to schematic No. 1400142 and to Figure 2-51 (Schematic No. 1400148 and Figure 2-52) while reading the description below.

2-166. *Frame Reference Generator.* With signal H REF applied to its D input, and signal V REF as its clock (both signals from the Reference PWA), the frame reference generator – a type D latch, distinguishes between field 1 and field 2 to produce the frame reference signal. This is a square wave. Thus, a reference frame signal is developed from input video. The reference frame signal produced by the reference frame generator is used by many circuits. It is output (through an inverter) as signal REF FRAME - to the color framer and Time Code Reader/Generator PWA's, and as signal MONITOR FRAME to the MONITOR I/O connector, on the VPR rear panel. It goes to the color frame reference divider where it serves as a clock signal. It goes to the variable tracking circuit to fire the one-shot. The reference frame signal is pulse formed into a narrow pulse and sent as a clock to the phase comparator, and to the unity/variable/self reset logic to serve as the unity frame reference input.

The frame rate counter can operate in any of three different modes: unity, variable, and neither - in which case the counter resets itself in the absence of reference input or during edit record freeze condition. Mode selection is under control of the unity/var/self reset select logic, and the UNITY/VAR switch (PWA front edge).

2-167. *Unity Mode.* Unity mode is effected with the UNITY/VAR switch in the UNITY position. The unity/var/self reset logic selects pulse formed frame reference from the frame reference generator, rejecting that of the variable tracking one-shot. The narrow pulse resets the frame rate counter via select logic. Once cleared, 2H CLOCK (from Reference PWA) begins incrementing the frame rate counter. The counter divides the input clock to produce signals H/2-through-H/12. These divided H counts are supplied to the coarse and fine resolution PROM's which interpret them as gradations of frame time.

The highest order address bit for both PROM's is supplied with signal 50 Hz/60 Hz SELECT – a steady state signal from the Reference PWA. This address bit dedicates PROM operation ot either 50 Hz or 60 Hz operation by selecting only that portion of PROM memory that is suitably programed for the system in use. The next lowest address bit for the coarse resolution PROM receives signal BLINK from the Control PWA. This alternating signal from the Control PWA. This alternating signal effectively divides the half of PROM memory in use – in half again, selecting one-quarter portion or the other according to its high or low state. This action (along with other PROM inputs) produces the narrow on/off LED pulses (PROM output (Q1) fed to the phase comparator. Here, the timing of these pulses relative to the frame reference clock determines the condition of the control panel tracking lamp; on, off, or blinking.

Supplied with these inputs and those from the frame rate counter, the coarse resolution PROM outputs the following signals to the fine resolution PROM (besides on/off LED, described above, field 1/2 (Q2), reset gate (Q3), and CT edge (Q4).

The fine resolution PROM uses these and frame rate counter inputs to produce signals; reset (Q1), chatter inhibit (Q2), CT pulse (Q3), and flag Q4, which are supplied to the latch. The latch "captures" these inputs upon the alternate transition of REF 2H CLOCK and presents them at its outputs as signals self reset, var chatter inhibit, CT edge, and flag respectively.

Signal CT edge clocks the frame rate reference generator which activates signal servo reference – sent to the control track servo. On 525 version boards, CT edge goes to the CT record generator which initiates signal CT record to the CT record

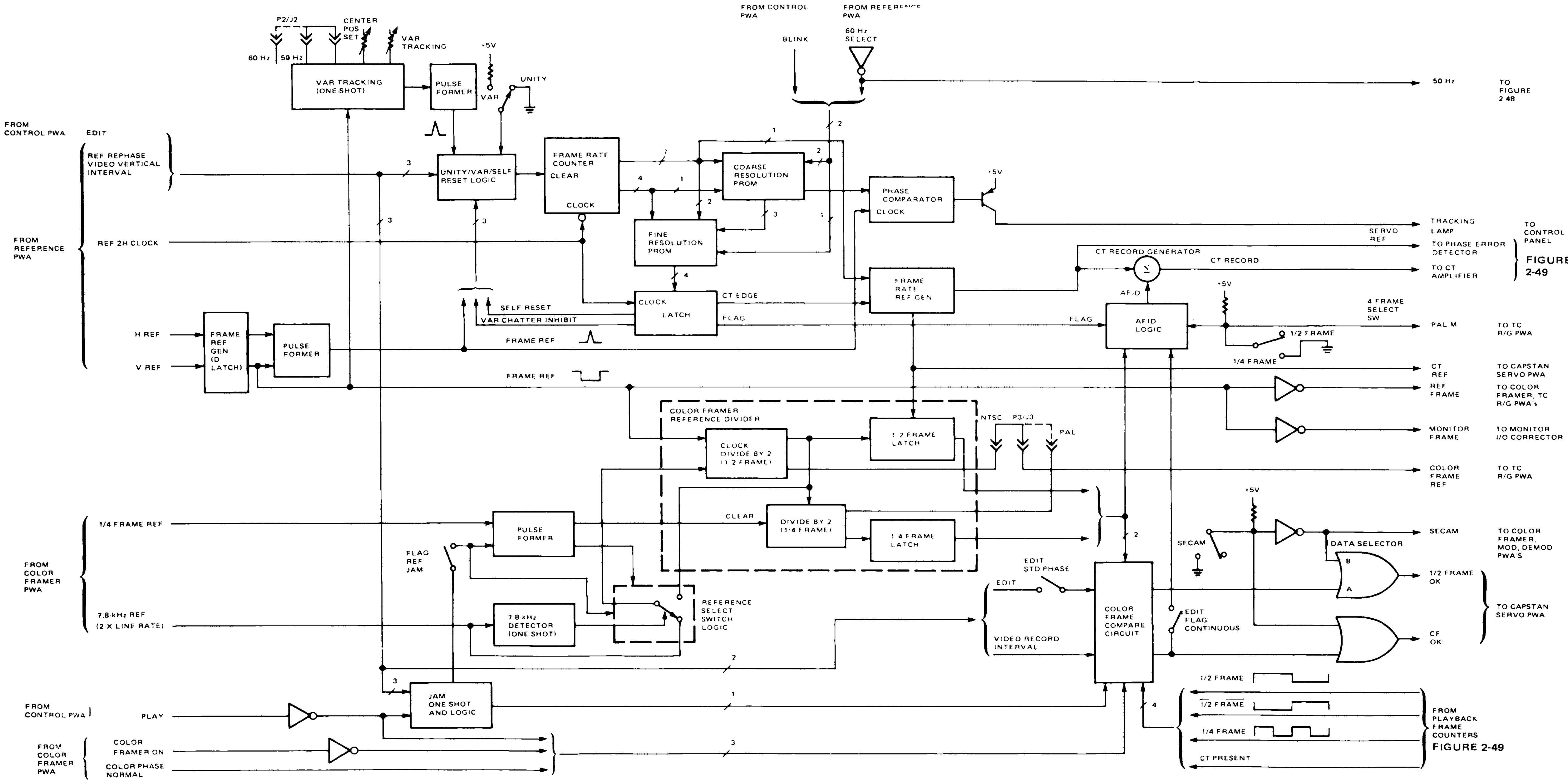


Figure 2-51. Control Track PWA Tracking and Color Framing Circuits – 525 System

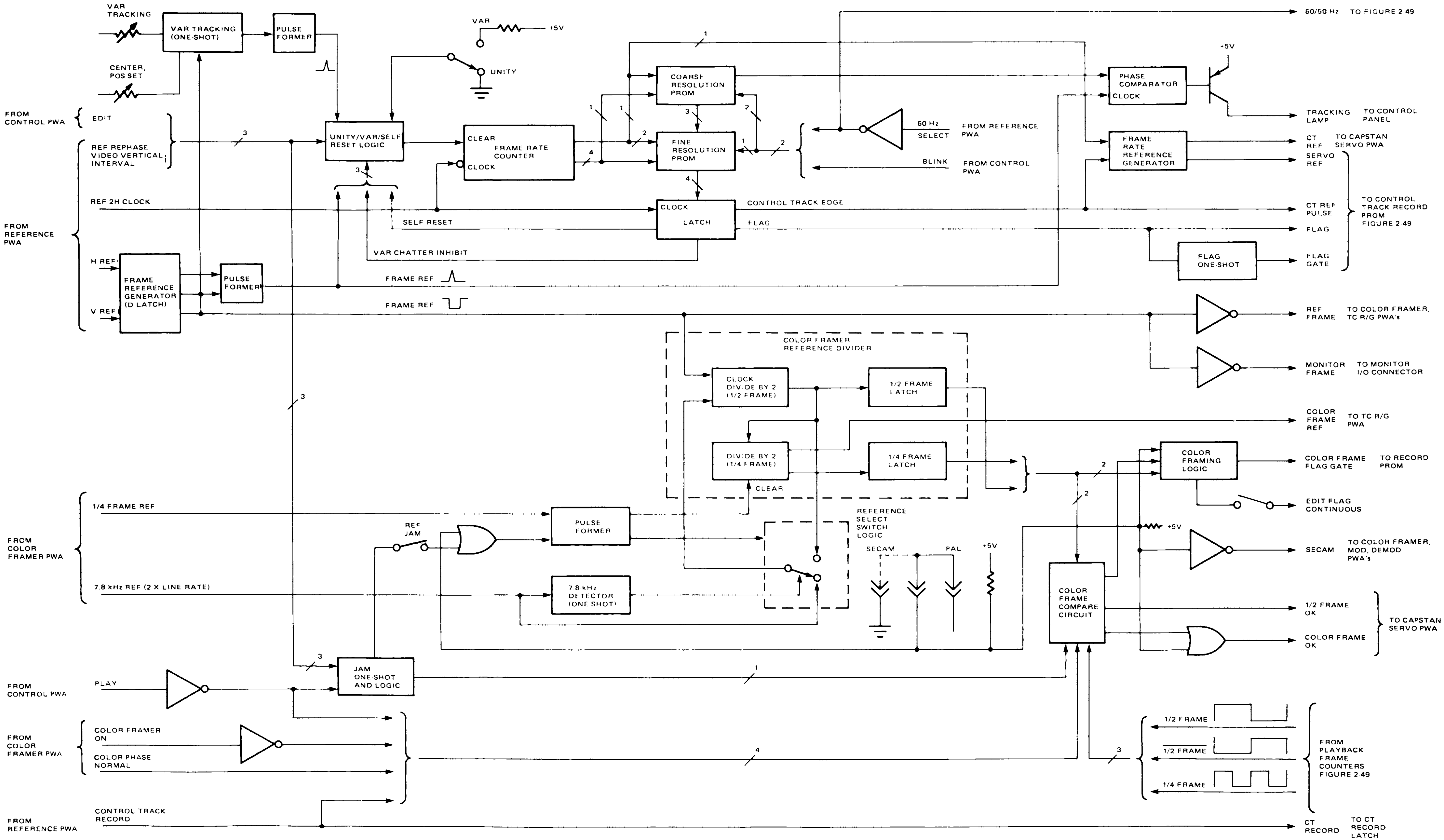


Figure 2-52. Control Track PWA Tracking and Color Framing Circuits — 625 System

amplifier via the OR gate. The frame rate reference generator also forces CT REF which clocks the 1/2 frame latch, and is output to the Capstan Servo PWA.

Signal flag (when it occurs) arms the CFID logic. When thus enabled, the CFID logic can force a CFID flag, via the OR gate of the CT record generator. The presence and timing of the CFID flag out of the CT record generator is controlled by color framing circuitry. Control track and CFID pulses are effectively summed together, and go to the CT record amplifier where they are recorded under control of the CT record latch. On 625 version boards, signal CT edge goes directly to the record PROM to produce the control track pulse during record mode. The frame rate reference generator also forces CT REF command to the Capstan Servo PWA.

Signal flag (when it occurs) goes to the record PROM, and fires the flag gate one-shot which initiates signal flag gate to the record PROM. These signals produce the color framing CFID pulse via the record circuitry.

2-168. *Variable Mode.* The purpose of variable tracking is to achieve optimum video playing conditions and to make possible contiguous edits. The adjustment range for variable tracking is ±10 ms. Normally, adjustments of ±3 ms (a few lines) are all that are required to peak tracking on one machine to a recording made on another.

Variable tracking can affect lip-sync. Multi-generation tapes made using variable tracking can accumulate error to the point where lip-sync error is noticeable.

The variable tracking one-shot (fired by the frame reference signal) is operative in both unity and variable modes. The unity/var/self reset select logic, however, accepts that input determined by the unity/variable switch. With this switch in the variable position, the unity gate (of the select logic) is disabled, and the variable gate is enabled, passing the variable input from the one-shot (via pulse former). The phase relationship (plus or minus) between input video and control track on tape (tape position) is determined by the one-shot time out period. The time out period is operator controlled via the PWA front edge VAR TRACKING control. The center position set potentiometer centers the action of the VAR TRACKING potentiometer around unity tracking.

The output of the unity/var/self reset select logic clears the frame rate counter just as it does in the unity mode. The counter, PROM's, and latch also work in the same way. The same signals are produced, including the control track and color framing signals which are subsequently recorded on tape.

The var chatter inhibit line out of the latch serves to block the variable gate of the unity/var/self reset select logic at all times except during a narrow window in which a control track signal is allowed to be recognized. This action effectively prevents spurious control track and reference signals from being generated when in the variable mode, or when no valid reference video input is present.

2-169. *Self Reset Mode.* The self reset line feeds back from the latch to the counter reset via unity/var/self reset select logic. This line will keep the frame rate counter operating at a frame rate – even if all else fails. This is true regardless of what position the UNITY/VAR select switch is in. The self reset line is activated by the PROM's when the counter reaches a certain count, indicating that frame reference time has expired, and none was received from the video input.

2-170. *Tracking Indicator.* The phase comparator consists of a type D latch. Its D input monitors an output line from the coarse resolution PROM while being clocked by the untiy frame reference signal. The phase relationship between these two signals is a measure of tracking deviation with respect to unity. The latch output operates the control panel TRACKING indicator (and LED) – via a transistor driver. Circuit operation is as follows:

LED expired	– unity tracking is indicated (deviation is within the unity window). This holds true whether unity or variable tracking mode is in force.

pulses. The level of charge is sampled by A4 and stored by C5 at the ramp's positive peak. A1 buffers C5. The buffer output is a speed sense signal which goes to speed sense comparators, and (through processing) to the velocity error amp and another speed limit sense comparator. Comparators A8-12 and A8-13 compare this signal with voltage thresholds to sense when the capstan is within ±7% of play speed. The outcome is sent to control logic.

The trailing edge of the tach pulse resets (via tach amplifier) the speed detector circuit, enabling another sample to commence. The greater the period between tach pulses, the more positive the speed sense signal developed.

Comparator A8 detects when the capstan is operating below 1/5 normal speed. When this condition occurs, and a variable signal is true, then slow motion pulse drive operation is established.

2-143. Velocity Error Amp. The input to the velocity error amp constitutes a summing point — the components of which are: actual capstan speed information from the speed detector; speed program voltage (of opposite polarity) from speed program generator, and; when in tape speed override (TSO) mode, TSO voltage from the locator remote panel. The velocity error amp produces a velocity error signal from this summed input voltage. The amplified error signal is used to control the speed of the capstan motor. During normal speed playback, the amplifier output is summed with a control track error signal (from Control Track PWA). The slow pulse select switch selects the resultant voltage to drive the capstan, except when pulse drive permit is in force.

When the VTR is not using the capstan, as in stop or shuttle modes, the velocity error amp is switched off (signal play inactive). When entering play or record modes, the speed program generator provides a signal to the summing point which ramps slowly to a reference level representing desired motor speed. Tape speed thereby starts slowly, accelerating to play speed period in about 1/2 second.

2-144. *Speed Program Generator.* During normal play, capstan speed is determined by play speed reference from a resistor-divider network. During variable speed operation, signal capstan variable becomes true. This signal, by means of two switches of the speed program generator, selects different voltages to be supplied to the amplifier.

One voltage is slow speed control, which is controlled by the position of the shuttle knob on the control panel. The other is +5V reference with which signal slow speed control is compared. The amplifier output is summed with that of the speed detector to control capstan speed according to the position of the shuttle knob. The variable speed limit set potentiometer (R24) is set to limit the maximum capstan speed in variable mode. At speeds below 1/5 play speed, signal pulse drive permit becomes active, causing the slow-pulse select switch to substitute the pulse drive signal for that from the velocity error amp.

2-145. *TSO Operation.* During TSO operation, a TSO component (either remote or local) is added to the velocity error summing junction. If capstan control logic acknowledges TSO request by issuing TSO command, TSO control voltage is connected to the summing junction. TSO operation is only allowed when the speed program generator is operating at standard operating speed. The input to the summing junction from the speed program generator is (at this time) fixed since it is based upon the play speed reference. The voltage of the TSO signal received is allowed to alter capstan speed within limits. The range for TSO is limited to ±15%.

2-146. *Pulse Drive System.* This system drives the capstan motor only when: (1) the VTR is in variable mode, and (2) capstan speed is below 1/5 normal play speed. A comparator of the speed limit sense circuit monitors processed speed sense signal from the speed detector. When this analog voltage drops to a certain value with respect to play speed reference, the comparator output toggles, signaling the pulse drive permit logic to enable pulse drive.

The pulse drive generator consists of a tach counter, a variable interval monostable, and a NAND gate. The time out interval of monostable A2-5 is controlled by signal PULSE CTL, which originates with the slow motion/shuttle control (front panel).

circuit – where they are compared (by exclusive OR gates) with playback 1/2 frame/1/4 frame signals from the playback frame counters. The results of the comparisons are latched to provide CF OK and 1/2 FR OK signals – both to the Capstan Servo PWA. These signals reveal color framing status. With a 2-frame system (NTSC) the 4-frame select switch is open and the data selector selects a constant "OK" condition to output on the 1/2-line OK line. With PAL-M, the data selector selects output from the color frame compare circuit; this signal must always be right and the resultant 1/2 frame OK output must be asserted.

The SECAM switch is always open on this PWA as this PWA is not used for SECAM operation.

The EDIT STD PHASE switch allows or denies the operator control over color framing phase. When open, the operator can make either normal or inverted edits. When closed, the operator has no control, and edits will always be of normal phase when in the edit mode.

2-176. Color Framing Logic – 625 System.

2-177. *Color Framer Reference Divider.* This circuit is comprised of four type D flip-flops (see Figure 2-52). The first stage provides the 1/2 frame reference keyed by the 7.8-kHz REF. The second stage provides the 1/4 frame reference – which is the color framing reference. In SECAM, this signal serves as an arbitrary color framing reference.

The input stage D line receives 7.8-kHz reference from the Color Framer PWA. It is clocked by frame reference from the frame reference generator. The resulting output is a phase locked 1/2 frame color frame reference signal.

If the Color Framer PWA detects monochrome video, it withholds 7.8-kHz REF. The 7.8-kHz detector one-shot fails to get fired. The inactive one-shot output causes the select logic to reject the external 7.8 kHz reference, and select feedback from the color reference divider – looping it back on itself. In this way, color frame reference can be maintained. The next 1/4 frame divider stage (color framer reference divider) divides the 1/2 frame reference signal by two to produce signal COLOR FRAME REF (a 1/4 frame reference signal.

The output 1/4 frame reference signal COLOR FRAME REF may or may not be subject to being rephased by the Color Framer PWA, depending upon the position of the reference jam switch. With the reference jam switch open and the PAL/SECAM jumper in the PAL position, signal 1/4 FRAME REF is enabled through the pulse former, and may clear the 1/4-frame divider. The Color Framer PWA may rephase the divider in response to its input conditions. This could occur at any time. With the switch in the closed position (reference jam), the color framer is inhibited from rephasing the 1/4-frame divider during any record mode.

The jam one-shot and logic senses the various conditions to enable/disable the pulse former as appropriate. Wtih the PAL/SECAM jumper in the SECAM position, the pulse former is disabled preventing rephase from occuring. In addition, signals SECAM and CF OK are asserted continuously.

2-178. *Color Frame Compare Circuit and Color Frame Logic.* Operation for these circuits is determined by the mode of operation, the PAL/SECAM jumper, the edit flag continous switch, and various signal inputs. If command CF ON from the Color Framer PWA denotes that the color framing system is shut off, the color frame compare circuit asserts signal CF OK to the Capstan Servo continuously. If the PAL/SECAM jumper is in the SECAM position, CF OK and SECAM are asserted continuously. During CT record mode (signal CT RECORD from Reference PWA is true), comparison circuit action is frozen because clock signals to the latches cease.

During playback, this circuit compares the phase of the components of 1/2 or 1/4 frame playback control track signal with those of the color framer reference divider. Exclusive OR gates compare 1/2 frame and 1/4 frame signals, with the results applied to latches to retain the compare/non-compare status. If a 1/4 frame non-compare occurs, command CF OK is rescinded, and color framing logic shifts CF gate position (sent to the record PROM) by two frames.

When closed, the edit flag continuous switch forces color framing logic to produce signal CF flag continuously through edits. Command COLOR PHASE NORMAL is controlled by the phase

norm/invert switch of the Color Framer PWA. When switched, it inverts the action of signal CF OK to the Capstan Servo.

2-179. Color Framer PWA No. 13. This PWA accomplishes four functions for the VPR. The color framer provides:

1. Composite sync to the Reference PWA – developed by the color framers reference video sync stripper circuit.

2. A 7.8-kHz reference to the control track servo system – used to provide the VTR with a 15-Hz (12-1/2-Hz) (1/2-frame rate) master reference. This master reference is required in PAL, PAL-M, and SECAM systems for correct color video operation during record and playback.

3. A 1/4-frame rate reference signal to the control track servo system – used on PAL and PAL-M systems to provide color frame referencing.

4. Local operator controls, and remotely sourced operator controls. These PWA front edge controls (along with above named reference signals) allow identification and phase control over color frame/sync sequences. This action allows horizontal picture shift – which could accompany edits – to be minimized. Such shifts result from edits in which the VTR does not lock vertically to the proper color frame sequence of the input signal. Color detection is also provided, shutting down the system in the presence of monochorma signals.

2-180. *Color Framing and TBC's.* Most contemtime-base correctors (TBC's) operate similarly. They create a framework of composite sync and color burst and modulate the timing of the input video signal to place it within this framework. The modulation process consists of three basic steps:

1. The vertical sync of the input video signal is compared to the reference vertical sync to determine where the horizontal lines of the signal should be placed in the resulting raster. This step is a very coarse adjustment called "vertical centering."

2. The horizontal sync of the input video signal is compared to horizontal reference sync and the signal is shifted left or right in time to fit within the finished framework.

3. After horizontal sync positioning, the color burst is compared to the reference subcarrier burst, and the signal is further shifted left or right to match the phase of the reference subcarrier.

In NTSC systems, the video color burst. relative to horizontal sync, reverses phase every line, and the same line on two consecutive frames exhibits a reversed burst phase. Regardless of which phase is presented to the TBC, the TBC shifts the signal to make the phase match and reference phase. This means the TBC can accept any given signal and position it in the framework of sync and burst. When the same signal of the opposite frame is presented, it is shifted left or right of the original signal by 1/2 cycle of burst.

Current NTSC specifications define the frequency and sequence relationship between video sync and color burst but do not define the absolute phase relationship between them. Unless the input reference to the TBC is in exact agreement with the references that created the original video signal, the TBC always shifts the picture content slightly from the original. This shift is random and can be up to a magnitude of ± 1/2 cycle of subcarrier. The color framing system limits this shift to ± 1/4 cycle of subcarrier.

This shift can be seen in two ways:

1. Video horizontal blanking is widened. The TBC inserts new blanking over the original blanking. When there is a shift, the total blanking width is modulated and can only become wider.

2. The picture or scene content visibly jumps sideways as a result of switcher action or an edit in the videotape. In most cases, this jump is not objectionable as the change in scene content usually provides little reason to notice the shift. However, where like picture content is being edited, the jump can be objectionable.

2-181. *Color Framing Description.* In NTSC, PAL and SECAM systems, the luminance and chroma information is encoded in such a fashion that the video sequence repeats once every four fields. While the control track system of the capstan servo is capable of generating a frame-rate reference, the machine must operate at a nonambiguous 1/2 frame rate 15 Hz (12-1/2 Hz). In the VPR, the basic chroma-encoding sequence is detected and sent to the control track circuitry to produce the 1/2-frame referencing and control.

In SECAM video systems, this is as far as the VTR need go. In a practical sense there is no real difference among successive four-field groupings.

In PAL video systems, however, there is a difference among successive four-field groups — the phase of the color subcarrier is reversed. A function of the time-base corrector is to force video to match a reference subcarrier phase exactly. If the TBC reference is producing field-one video and the VTR is providing field-five (opposite phase) information, the TBC will shift the picture content by one-half cycle of the subcarrier. This is a horizontal picture shift, described above.

To provide control of this situation, the control track signal is encoded in an eight-field sequence. The color framer system detects the phase of subcarrier during the recording process and provides the 1/4-frame reference signal necessary for this encoding. During the playback process, the same signal is used as a playback reference. The control track and capstan servo systems are capable of comparing the playback control track signal to the 1/4-frame reference and forcing the tape to match its reference.

The VPR color framing system encodes the recorded control track signal to permit identification of particular frames. The standard control track signal is a squarewave (a series of positive and negative pulses, PAL/SECAM) that occurs at a frame rate. It is modified by the addition of a short flag pulse to identify every fourth frame. Upon playback, it is possible to force the capstan servo system to position the signal in accordance with a 1/2- and/or 1/4-frame-rate reference. All circuitry required to produce the proper recorded signal, and to identify and control the playback of this signal, exists within the control track servo system of the standard VPR.

The Control Track PWA generates the 1/2 frame (1/4 frame) reference necessary to produce and record the flag. It also decodes the flag during playback and notifies the Capstan Servo PWA when the playback signal is on the selected field. The Capstan Servo PWA will operate at the wrong speed during play runup until the control track system has slipped to the correct track. Then it will permit the tape to operate at normal speed and normal servo operation. At no time does the VPR attempt to observe off-tape video to determine color frame phase.

The Color Framer PWA provides the control track system with two necessary inputs: operator chosen mode commands (color framer playback enable and frame choice), and the 1/2- and 1/4-frame references. Left to itself, the Control Track PWA would encode the color frame flag arbitrarily. Likewise, it would select a playback track arbitrarily.

2-182. Color Framer PWA Theory. Refer to Figures 2-53 and 2-54, and to Schematics 1400132, 1400135, 1400138 (NTSC, PAL/SECAM, PAL-M/SECAM, respectively) while reading the description below. Much of the color framer circuitry is common between NTSC, PAL/SECAM, and PAL-M/SECAM version boards. Theory test for such circuitry may be found under the appropriate circuit or function heading (without reference to NTSC, PAL, etc.). Circuitry which is unique to one version board or the other is identified by inclusion of applicable term NTSC or PAL/SECAM in the paragraph heading. Figure 2-54 is a block diagram for both PAL/SECAM and PAL-M/SECAM version boards.

2-183. *External Reference Sync Stripper.* The VPR must have external reference composite sync, or it cannot be externally referenced. The external reference sync stripper circuit (Figure 2-53) produces this signal, and sends it to the Reference PWA. External reference video (from VPR rear panel) terminates into the transistor emitter-follower amplifier. The buffered video is then supplied to the times-three amplifier through a low-pass filter (it is also sent to reference select circuitry to be used as one of two possible system

reference video signals). The times-three amplifier output divides in two directions. It goes to the slicer after passing across sync tip clamp diode CR1. The buffered/amplified video also goes to the sync stripper which uses it to develop a bias voltage for the back porch sample-and-hold circuit.

The back porch sample-and-hold employs two transistors acting as a switch to drive the FET switch. The FET switch dumps current samples into a capacitor. The resulting integrated voltage is the slicing level reference, which is sent to the slicer. Thus, the slicing level can be maintained with precision (by varying the slicing level reference) regardless of variations in input reference video amplitude. The resulting slicer output is the external reference composite sync signal sent to the Reference PWA.

2-184. *Reference Select Circuit.* The reference select circuit receives buffered external reference video (from emitter follower) and MOD VIDEO (from Modulator PWA), both of which are candidates to be system reference video. Selection is made by the Reference PWA via command sync select (REF SELECT BUS) – operating the reference select switch. Both video signals (prior to the reference select switch) receive the same treatment, passing through high-pass filters and chroma amplifiers. The choice (command SYNC SELECT VIDEO/REF) is made by the sync select switch of the Reference PWA (auto/external/video). The selected reference video is supplied to the burst gate switch.

2-185. *Burst Gate Generator and Switch.* The signal supplied to the burst gate switch is all of the chroma that constitutes the video signal. It is the function of the burst gate switch to separate the burst (only) from the video signal, and pass it to the burst slicer. The burst gate generator is a monostable (3 microseconds) fired by signal SELECT COMP SYNC, and cleared by REF H. The output closes the burst gate switch, coupling all of the burst through an entire field to the burst slicer (via emitter follower on PAL/SECAM version). The burst slicer converts the burst signal to TTL level pulses.

2-186. *Standard Phase Detector.* The standard phase detector is a type D latch which responds to the timing (or phase) relationship between reference video burst and SELECT COMP SYNC (from the Reference PWA).

The sliced TTL level burst is routed through a burst pulse former, and applied to the D input of the latch. These tiny pulses represent (approximately) 60 to 70 degrees of burst phase.

The latch is clocked by the trailing edge of a burst sample signal from the burst sample generator. This circuit is a monostable fired by the leading edge of the selected reference sync signal. Thus, after a time delay (controlled by potentiometers ref std cal/video std cal), the standard phase detector "examines" the phase of burst against that of composite sync. If the clock signal clocks the latch between the burst pulses, the latch does not recognize a reference phase relationship. The standard indicator drive (a one-shot) is not fired, and the green STANDARD indicator LED is not lit.

If the phase of a burst pulse and clock signal coincide, the standard phase detector latch recognizes a reference phase relationship, and the STANDARD indicator is lit (via one-shot). Additionally, it phases the divide-by-two counter divide-by-four counter, PAL/SECAM), producing a phase output of signal 7.8 kHz REF (1/4 frame Ref, PAL/SECAM) which is proportional to that detected by the standard phase detector. This action repeats once every fourth field where (1) sync-to-burst timing relationship is measured to determine whether it falls within a certain window; (2) if it does, the divide-by-two (-by-four) counter is reset and the phase of the resulting 1/4-frame reference is slaved to the VTR reference video, and; (3) STANDARD drive indicator circuit is activated, lighting green LED.

2-187. *Burst Sample Generator.* This circuit consists of a monostable with an adjustable time-out period. It provides the clocking signal (trailing edge of time-out) used by the standard phase detector in the manner described above. It is fired by signal SELECT COMP SYNC, and inhibited by REF V (via one-shot, PAL/SECAM) when true. Time-out potentiometers ref std cal and video std cal are adjusted so that the standard phase detector recognizes the desired cycle of burst. A CMOS switch controlled by command REF SELECT BUS

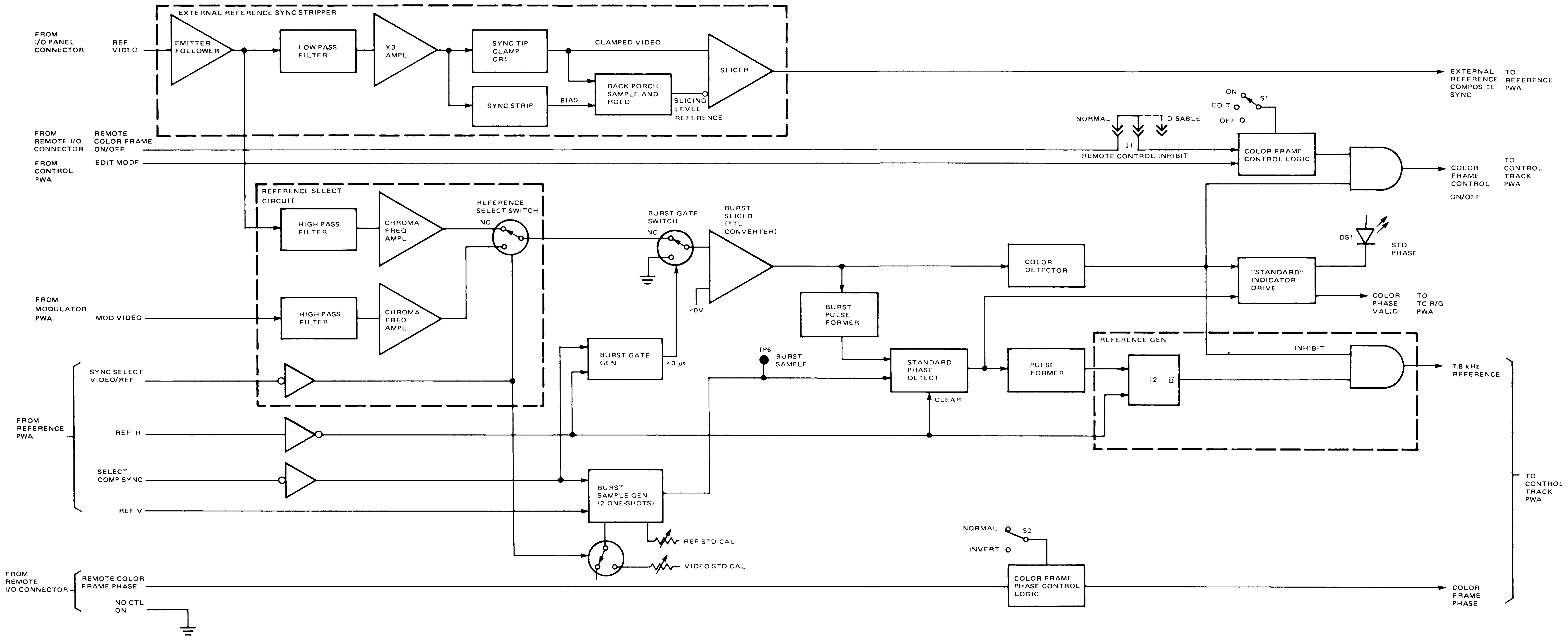


Figure 2-53. Color Framer PWA, NTSC

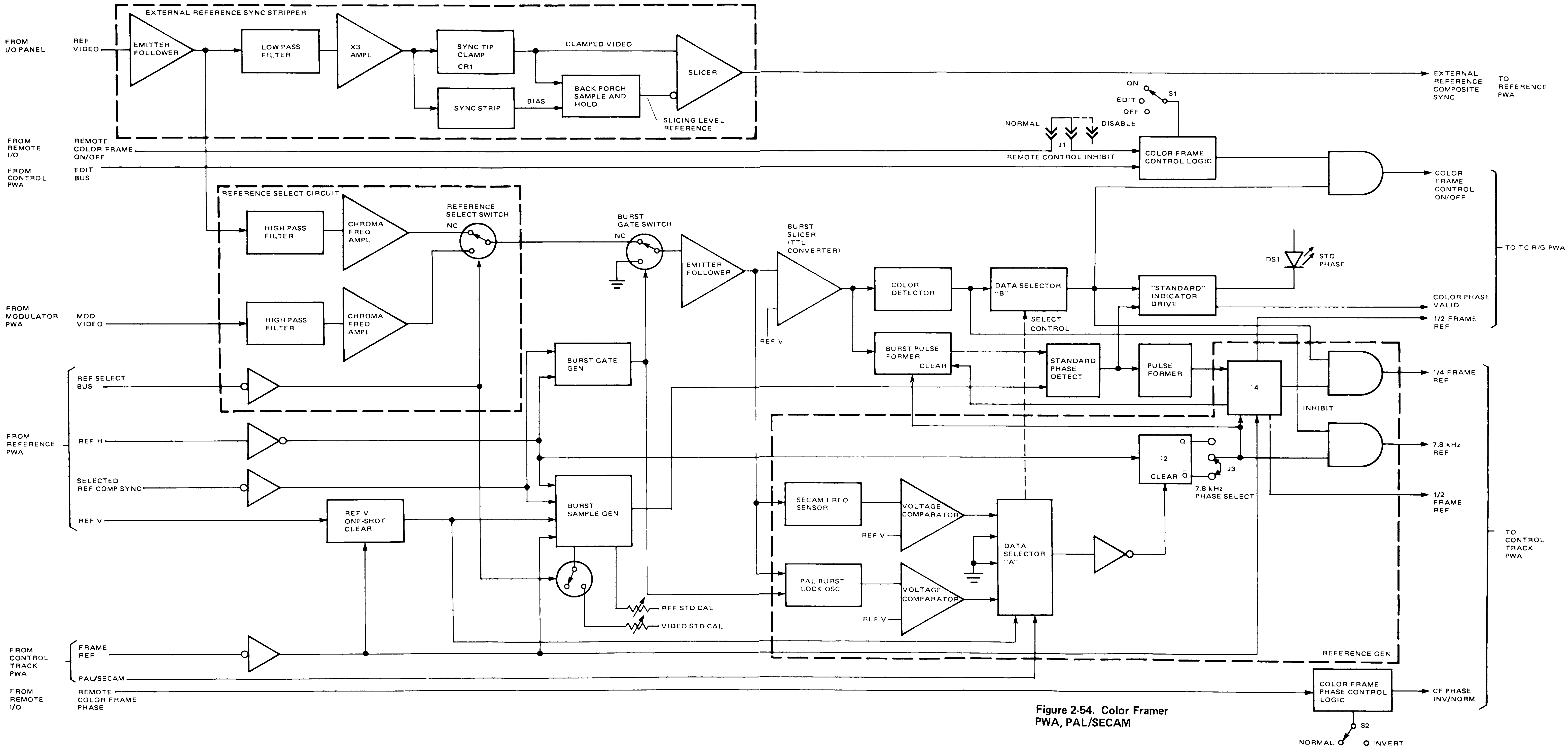


Figure 2-54. Color Framer PWA, PAL/SECAM

(which determines reference video selected) installs the video std cal pot when modulator video is selected, or removes it when reference video is selected. The two pots are configured in series so that, once the timing relationship between the video input and reference input is fixed, any further adjustment to front edge ref std cal control will tend to vary tracking for both of them equally.

2-188. *Color Detector.* This circuit consists of a transistor amplifier and slicer which senses the presence of burst at the output of the burst slicer. If burst is detected (denoting color signal), the color detector output:

- Enables standard indicator drive (through data selector, PAL, PAL-M). This allows LED to be lit and command COLOR PHASE VALID to be forced to TC R/G PWA.
- Enables 7.8 kHz REF and 1/4 FRAME REF and COLOR FRAME CONTROL (and 1/4 FRAME REF, PAL, PAL-M) to be asserted when true.

2-189. *Reference Generator – NTSC.* The NTSC reference generator consists of a divide-by-two counter and a gate. The counter is clocked by REF H to produce the 7.8 kHz required by color framer circuitry of the Control Track PWA. This signal is the color framing reference in the NTSC system. The phase of the output is subject to being phased by the standard phase detector (via pulse former) when standard sync-to-burst is recognized. The output is inhibited – when color is absent – by the color detector circuit.

2-190. *Reference Generator and Data Selector – PAL/SECAM.* Like the NTSC reference generator, the PAL/SECAM reference generator employs a divide-by-two counter clocked by REF H to produce the 7.8 kHz command used by Control Track PWA color framer circuitry. The phase of this signal is controlled by the phase select jumper J3 (in phase, or 180 degrees out) PAL/SECAM boards employ a SECAM 7.8-kHz detector and a PAL 7.8-kHz detector. One of these circuits may be chosen through the data selector (section A) to force the phase of the 7.8 kHz (divide-by-two) counter circuit. The data selector is under control of commands PAL/SECAM and REF V. Configuration is such that at the trailing edge of signal REF V, either the SECAM or the PAL detected 7.8 kHz is chosen to phase the divide-by-two counter – depending on the state of command PAL/SECAM. Selection is for the duration of REF V one-shot time out only. At all other times, one of two data selector ground inputs is selected, preventing the counter from being rephased. The SECAM 7.8-kHz detector and the PAL 7.8-kHz detector with voltage comparators both examine video from the emitter follower.

The B section of the data selector, like the A section, is controlled by commands PAL/SECAM and REF V. In a SECAM system, grounded inputs only are selected and the COLOR PHASE VALID, 1/4 FRAME REF, and CF CONTROL signals are thereby always disabled. In a PAL system, the output of the color detector is always selected, and the above-named signals are enabled only when color is detected.

2-191. *Color Frame Control Logic.* This circuit produces command CF CONTROL which goes to the Control Track PWA and to the Capstan Servo PWA as signal CF OK. It is the purpose of this circuit to force command CF OK true when the color framing system is shut down, so that the capstan servo does not attempt to servo to color framing commands which are not valid. The circuit's output is locally controlled by PWA front edge CF ON/EDIT/OFF switch. The remote ON/EDIT/OFF switch, however, overrides the action of the local switch when the remote control inhibit jumper is in place (enable position). When in the ON position, the color framer is on all the time. In the EDIT position, the color framer is on only when the editor is on. In the OFF position, it is always off. The above modes are subject to remote override, unless jumper J1 is in the desirable position. The output passes through an AND gate which is armed by the color detector only when color is present.

2-192. *Color Frame Phase Control Logic.* This circuit consists of an exclusive OR gate controlled by local and remote phase normal/invert switches. Toggling either switch changes the invert/normal status of the CF PHASE command – sent to the Control Track PWA.

2-193. VIDEO CIRCUIT DESCRIPTION

2-194. General

The video system contains seven PWA's which provide interfacing and processing for the video signals. Four of these PWA's are located within slots in the electronics assembly rack.

The video system interconnect block diagram, Figure 2-55, includes the sync functions to meet the C format requirements. For a non-sync version of the VPR' the functional differences are as stated in the applicable PWA descriptions, below.

Referring to Figure 2-55, in record mode the video input signal is applied to the modulator, which then provides a modulated carrier to the record head, via the record amplifier. In playback the rf is pre-amplified and applied to the equalizer. The equalizer then provides rf signals to the AST servo board and to the demodulator. Three demodulated outputs are routed from this board to the back panel connectors, Video 1, Video 2, and Mon Video. The video system also includes a board which provides edit erase drive signals.

2-195. Equalizer PWA No. 4

This PWA equalizes rf playback signals, removing distortion caused by the record/playback process, to provide rf signals to the demodulator and AST servo. Metering rf signals for the video head, sync head, and record head (playback mode) are sent to the playback sync processor. Logic is provided to allow the auto chroma error to control equalization.

A sync version of this PWA provides for switching between the video head, sync head, and record head playback signals. A non-sync version has input circuitry for video head and record head playback signals only. There are sync and non-sync versions for both 525 line and 625 line use. The description of the equalizer, given below, applies to all four versions, with any differences specifically noted.

2-196. Input Circuitry

Refer to Figure 2-56 for a sync version of this PWA. Video rf, sync rf and record head playback rf signals are routed to the board via balanced cables and are applied to step up transformers. Single-ended transformer outputs are amplified and sent to the playback sync processor for metering purposes. These outputs are also applied to diode switches. The head switch command and the P/R head select command select one of the three inputs to be passed to the input filter circuit. For a non-sync version, the P/R head select command selects video rf or record head playback rf; a head switch command is not present.

2-197. Input Filter and AGC

The selected signal is applied to a low-pass filter (L13-16). The purpose of this filter is to prevent components of the edit erase signal from entering the demodulator during edit mode. After passing through this filter and a one stage equalizer the signal is applied to an AGC circuit. The signal is also taken off at this point to provide a monitor rf output, via a driver stage.

An output from the second cosine equalizer goes to a video detector (A3) in the AGC circuit. This detector provides a dc output proportional to the amplitude of the input signal. A difference amplifier (A8) compares this dc level to an adjustable reference level. The difference is amplified to provide a photocell current in an optical coupler (A4). The coupler determines the impedance of the AGC input amplifier and therefore its gain. This completes the AGC loop, the signal passing through the input amplifier (A9-6) to the first cosine equalizer.

2-198. Cosine Equalizers and D.G. Circuit

The function of cosine equalizers 1 and 2 is to compensate for high frequency record/playback losses without introducing phase shift. The frequency response characteristics of the cosine equalizers are dc voltage controllable.

In cosine equalizer 1, signal from the AGC circuit is applied via a delay line and emitter follower (Q15) to a differential gain circuit (A14). The

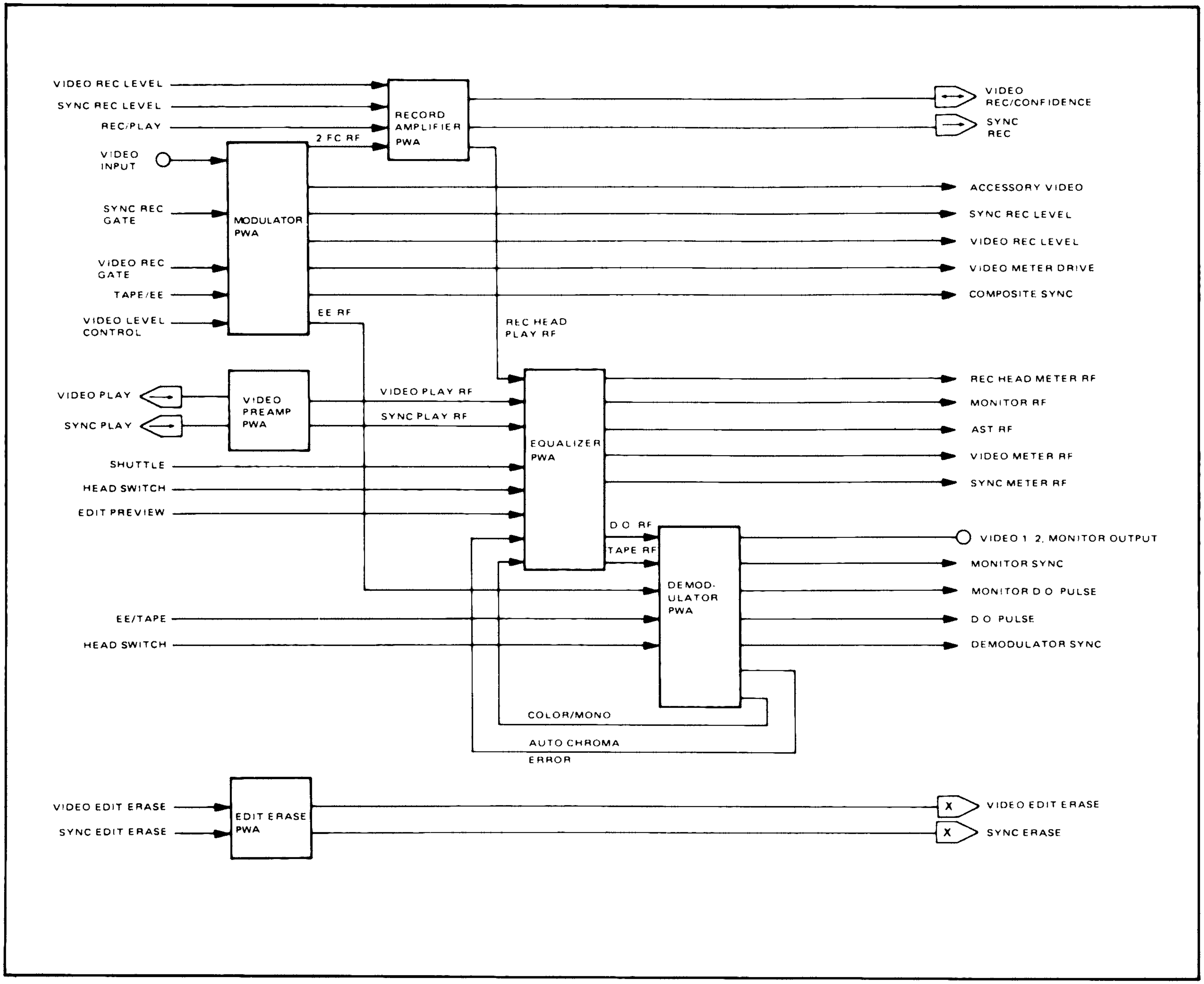


Figure 2-55. PWA Interconnect Diagram — Video Section

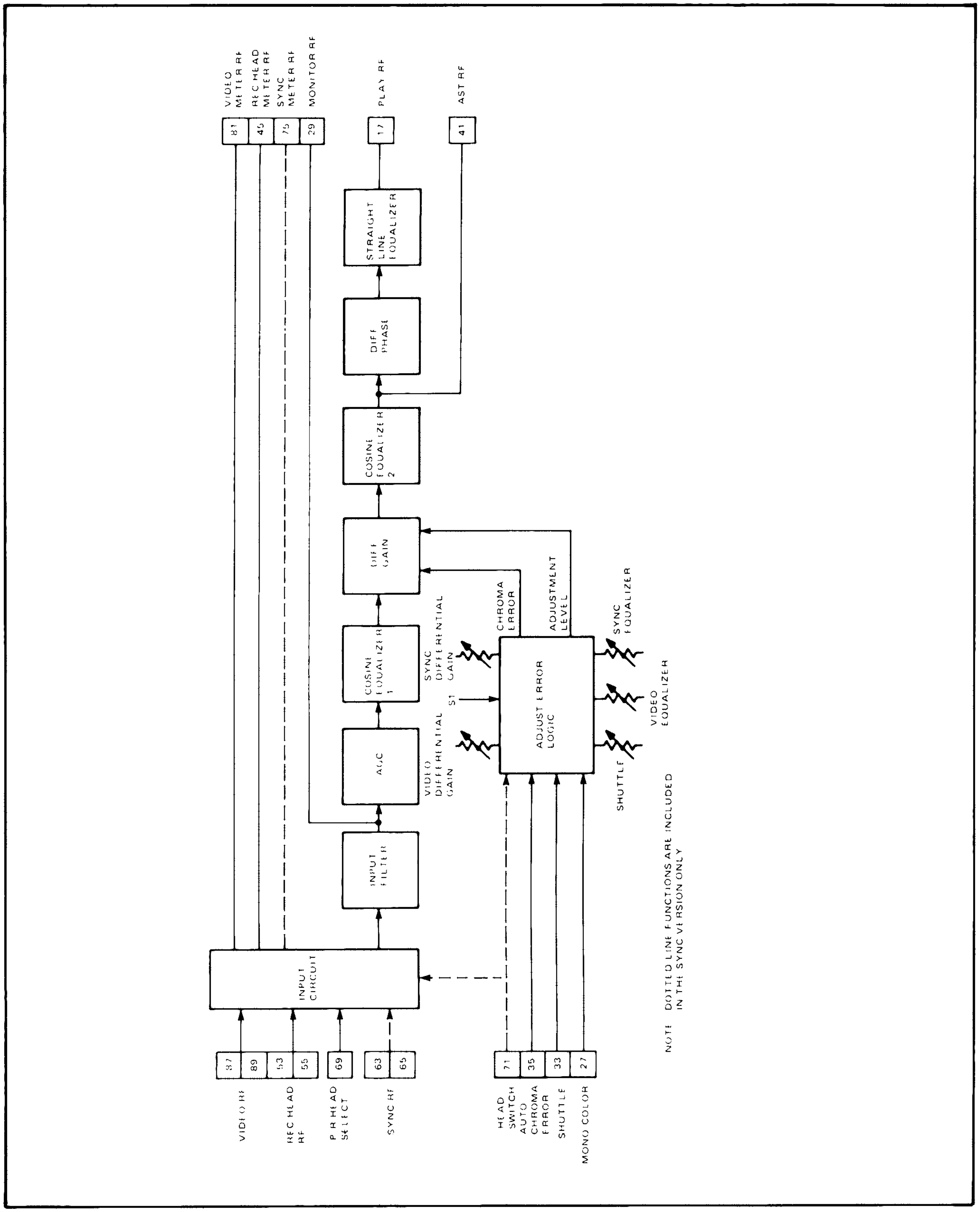


Figure 2-56. Equalizer Block Diagram

signal is routed to the differential gain circuit via a cusp amplifier (A15). The two signal paths are summed at the D.G. circuit input to provide a cosine function which partially compensates for high frequency head and tape losses. Equalization is adjustable by a cusp amplifier gain setting (sync, R192; non sync, R141). Also, a delay line termination factory adjustment is set for a flat response, to 20 MHz, out of the emitter follower (Q15). The differential gain circuit compensates for varying frequency response due to video brightness variations.

Also, the auto chroma error is added to the rf signal via the D.G. circuit. The partially equalized rf signal then goes to the cosine equalizer 2. This circuit performs the same function as cosine equalizer 1, and completes the equalization of the rf signal. A termination adjustment and an equalizer centering adjustment are provided.

2-199. Miscellaneous Circuits. One output of cosine equalizer 2 goes to the AST servo board, and another output is applied to a differential phase control circuit. This circuit provides a differential phase shift adjustment potentiometer. The signal is then passed through a straight line equalizer (L1, L2, L3) and sent to the demodulator.

The equalizer board also contains logic for switching in various front panel adjustments. For the sync version these adjustments are: video differential gain, sync differential gain, shuttle, sync equalizer, and video equalizer. These adjustments, and the auto chroma error signal, may be switched in according to the states of the shuttle signal, mono/color signal, head switch signal, and the auto/manual switch (S1). The non-sync version of this PWA does not include the sync differential gain and sync equalizer adjustments or the head switch signal.

2-200. Demodulator PWA No. 5

This PWA demodulates and amplifies tape rf from the equalizer of EE rf from the modulator, and provides three output video signals. It also detects rf dropouts, attenuates the burst signal, and generates demod sync, auto chroma error and mono/color signals. The description of this PWA applies 525 line and 625 line versions, with any differences specifically noted.

2-201. Demodulation. Refer to Figure 2-57. Diode switches activated by the EE/tape command select either tape rf or EE rf to apply to an input amplifier. The amplified signal is transformer coupled to a limiter to remove any amplitude variations. A limiter balance adjustment is provided to balance out even harmonic components of the square wave signal. The limiter output is applied to a pulse former circuit which produces pulses of a uniform width for each transition of the limited rf signal. The pulses are routed through a current mode switch (Q1) to a 5-MHz low pass filter (6-MHz for 625 line version). This current mode switch is controlled by a feedback clamp loop (paragraph 2-203) which maintains the blanking level of the output video signal at zero volts.

Unwanted signal components are removed by the low pass filter (L1, L2, L3). A phase equalizer circuit (L5, L6, L8, T2-4) compensates for group delay distortion introduced by the low pass filter. The low pass filter reconstructs the composite video signal by integrating the series of constant width pulses from the pulse former. In the absence of signal, during rf dropout, the average value drops below sync level.

The phase equalizer output is applied to a de-emphasis network (RC networks in a transistor (Q38) emitter circuit). The de-emphasized video is then amplified and applied to an output driver via a FET switching configuration. The FET switches are controlled from the dropout detector circuit (paragraph 2-202) to apply ground level to the output driver during dropout, clamping the video to black level.

Also, the video applied to the output driver is attenuated by 6 dB during burst. The trailing edge of sync triggers a one shot (A16) to switch in an attenuation circuit. The attenuation level is adjustable by a potentiometer. For a 625 line version of the demodulator, this attenuation circuit is disabled in SECAM use, by the SECAM/PAL command.

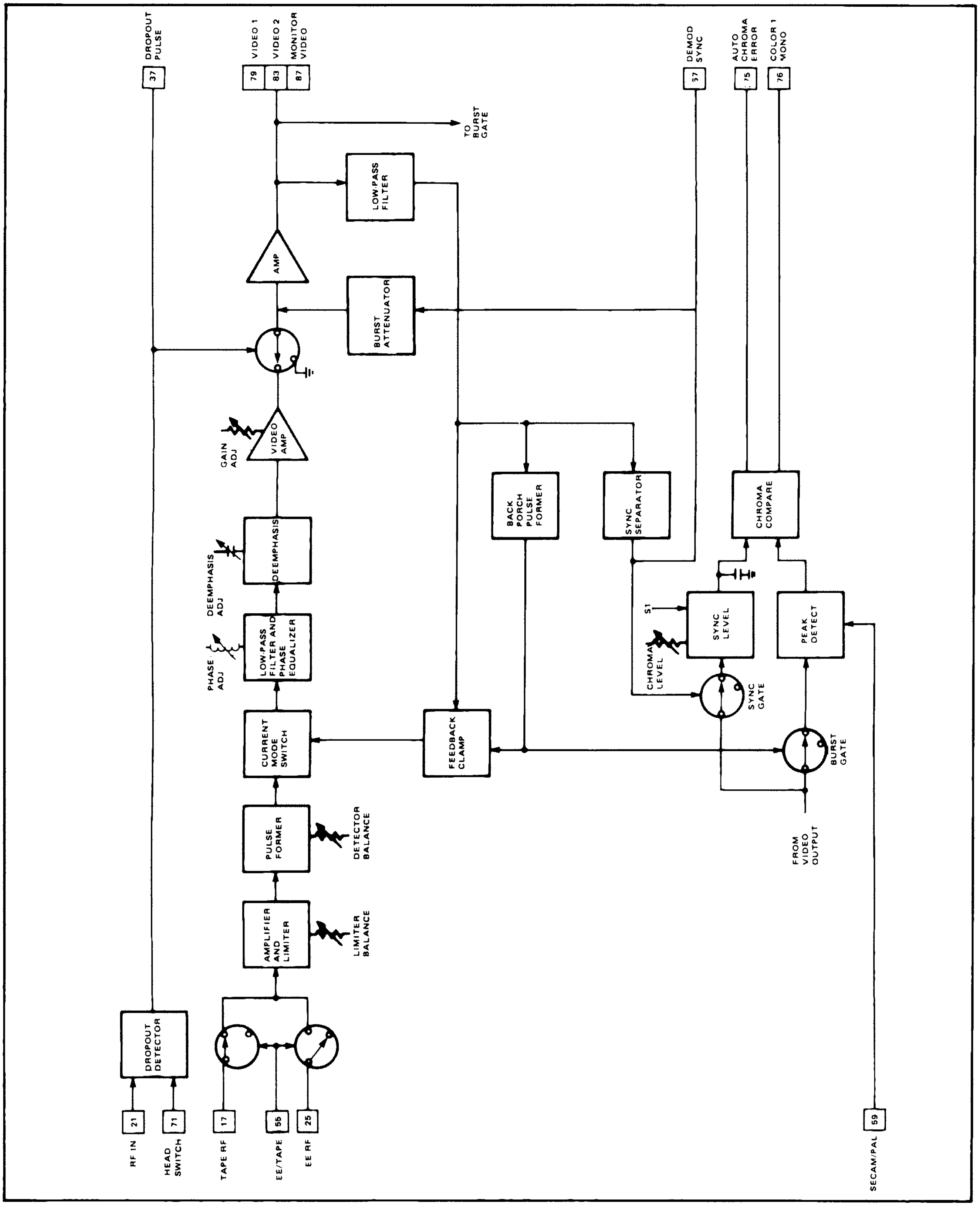


Figure 2-57. Demodulator Block Diagram

The output driver provides video outputs to three rear panel connectors: VIDEO 1, VIDEO 2 and MON VIDEO.

2-202. Dropout Detector. The dropout detector detects the occurrence and duration of dropouts. The resulting D.O. pulse is sent to the TBC. It also is used to control FET switches for clamping video to ground during dropout.

An rf signal from the equalizer is compared to an adjustable reference level which establishes the dropout threshold at approximately −15 dB. For machines with the sync option, sync information is present during the video dropout period. Therefore, the rf stays above the dropout threshold, no dropout pulse is generated, and the sync information is passed to the three video output lines.

Also, another circuit in the dropout detector develops two short dropout pulses during head switching between video and sync heads, for machines with the sync option.

These pulses, each of two microsecond duration, are used to clamp the video to ground during head switching transients. This circuit consits of one-shots which are triggered at the beginning and end of each head switch pulse. The resulting one-shot outputs are OR'ed with the outputs of the rf dropout detection circuit.

A head switch from the Playback Sync Processor is also routed to the dropout detector circuitry. It effects lowering of the dropout sensitivity during sync head time.

2-203. Feedback Clamp. The video output at test point TL13 is sent through a low-pass filter to remove burst then applied to the feedback clamp circuit (via Q10A). A FET (Q8) enables sampling of this feedback signal during back porch time. The sample controls the current mode switch (Q1) to effect clamping of the video output back porch level at zero volts.

2-204. Back Porch and Sync Circuits. The video feedback signal (at Q10A) is also amplified and applied to a transistor network (Q18, Q19, Q20) for forming a back porch pulse. This pulse is used for sampling in the feedback clamp circuit (Q8) and in the sync stripper circuit.

The video feedback signal is also ac coupled to a comparator (A9). The back porch pulse enables a FET (Q9) to a switch in a voltage divider, applying half the sync amplitude to the other comparator input. This level is sampled and held. A demod sync slice at about half the sync amplitude is produced. A transistor (Q11) inhibits this output during rf dropout.

2-205. Auto Chroma and Mono/Color Circuits. The back porch pulse (at TL8) is also used to separate burst. It enables a diode switch (A10) to apply a video feedback burst signal to peak detect circuitry (CR4, C95). The peak detected burst level is sampled and held, and compared (A21-10) to a sync amplitude. The sync level, sampled by a transistor (Q33) at sync time, is routed via circuitry that includes front panel switch S1 and the chroma level adjustment potentiometer (R64). Any difference between the sync and peak detected burst amplitudes produces the auto chroma error signal, which is sent to the equalizer.

The peak detected burst is also used to provide the color mono signal, denoting the presence or absence of color burst. In SECAM use, the SECAM/PAL command changes the gain of the auto chroma circuit.

2-206. Modulator PWA No. 6

The main function of this board is to frequency modulate a carrier signal with the incoming video signal. Pre-emphasis, AFC, and miscellaneous other functions are also provided. The description of this PWA applies to 525 and 625 versions, with any differences specifically noted.

The blanking carrier frequency of the 525 line version is 7.9 MHz, and the peak white deviation frequency is 10.0 MHz. For the 625 line version the carrier blanking frequency is 7.68 MHz, and the peak white deviation frequency is 8.9 MHz.

2-207. Input and Pre-Emphasis. Refer to Figure 2-58. The composite video signal is applied via pins 19/20 to an attenuator and a differential amplifier having a very high impedance input circuit. High and low frequency response adjustments are provided. The gain of a dual FET output stage is controlled by the video level control signal, via a constant current source transistor. The output is applied to a differential op amp (A4) which amplifies the signal to approximately 1.5 volts peak-to-peak. A unity gain adjustment is provided.

One of the op amp outputs is applied to pre-emphasis circuitry, for boosting high frequencies.

Closure of a switch (A3) during the burst interval selects a pre-emphasis configuration that provides an additional +6 dB of gain for the burst signal. This improves the signal to noise ratio of the reproduced burst. Pre-emphasis component values differ for 525 and 625 line versions of the PWA.

2-208. Modulation. After pre-emphasis, the video is applied to a ramp generator (Q2, Q3, C6). The resulting sawtooth activates a multivibrator circuit (A2, A6). Comparators (A2) look for upper and lower limits on the sawtooth. As the negative limit is reached, A6-2 discharges the ramp capacitor (C6). The resulting frequency is a function of the capacitor charging rate, the frequency varying linearly with the video signal. A potentiometer provides a linearity adjustment, essentially by varying the lower limit discharge point with frequency. The modulator operates at twice the desired carrier frequency, for prevention of second harmonic effects. The modulated signal is amplified and transformer coupled to provide balanced outputs. These outputs drive balanced cables to the record amplifier board, where the signal frequency is divided by two prior to recording. The modulated signal is also divided by two on the modulator board, to provide an EE rf output at pin 55 when in EE mode.

2-209. AFC. The AFC loop maintains the modulator frequency at twice the center frequency during the blanking interval of the input video signal. A tuned demodulator (A5) and a low-pass filter produce demodulated video, the blanking dc level of which will cause frequency change. The back porch pulse from the sync separator circuit (paragraph 2-110) causes sampling of the blanking dc. The sample is compared to ground and an error voltage is applied to the ramp generator circuit to correct the modulator blanking frequency. A potentiometer adjustment established the desired blanking frequency.

2-210. Miscellaneous Circuits. A second output from the video op amp (A4) is used for several circuit functions. It is applied through a low-pass filter to the ac coupled sync separator (A11), which generates a back porch pulse (A10-13). This pulse causes sampling of the back porch level (A4) in the feedback clamp loop (Q17, A8). The clamp loop compares this sample to ground and feeds an error signal back to the video op amp, clamping the video to ground. The sample level is maintained by a large capacitor, so the quiescent video (black) level is continuously clamped to ground, with the sample level being updated each back porch time.

The filtered op amp (A4) output is also applied to a 2 X burst switch driver (A12, A10-12, Q8-10) which uses a dc coupled sync separator to generate a switch drive pulse. This pulse closes the 2 X burst switch (A3) during the burst interval, for selection of the proper pre-emphasis configuration. Also, the stripped sync is used to provide a composite sync signal for the Reference PWA. For the 625 line modulator, the SECAM/PAL signal at pin 29 is high for SECAM use, disabling the 2 X burst switch drive pulse. The filtered op amp output is also used by a video meter drive circuit. The same op amp output, prior to filtering, is amplified to provide a video signal to the color framer board via pins 25/26.

The Modulator PWA also provides switching for video record and sync record control signals, which are sent to the record amplifier board. The switching is determined by video record gate and sync record gate signals from the Reference PWA.

2-211. Video Bypass PWA No. 7

The circuitry of this PWA consists of three coax cables which connect demodulator outputs to

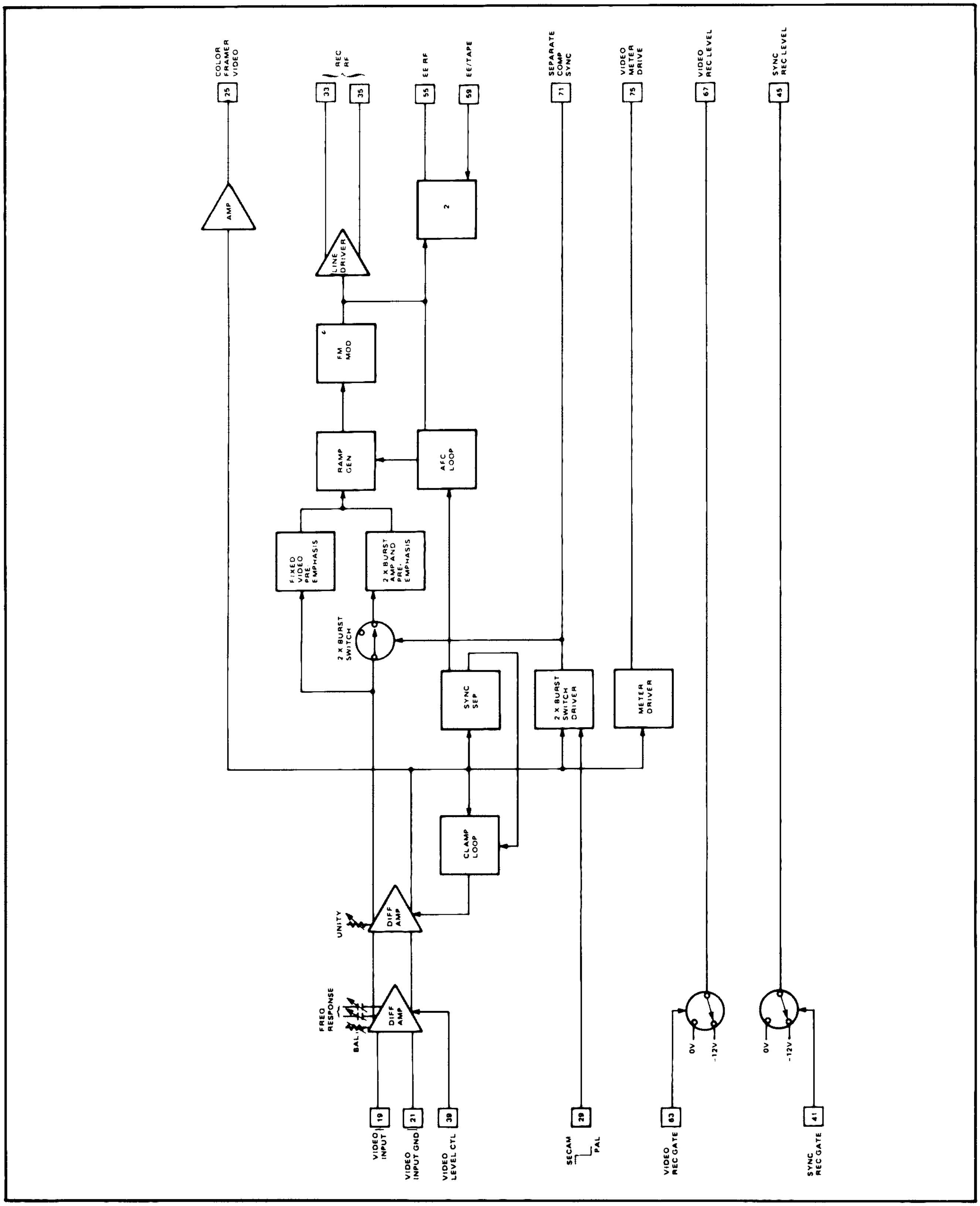


Figure 2-58. Modulator Block Diagram

cables routed to the VIDEO 1 OUR, VIDEO 2 OUT and VIDEO MON output connectors. The board provides test points for the three outputs, including ground reference test points.

2-212. Preamplifier PWA

Refer to the block diagram, Figure 2-59. A differential input from the video playback head is applied to a step up transformer. The transformer feeds a high-gain differential amplifier (Q1-Q4). The output of this amplifier is applied to a differential input op amp circuit. The op amp gain is adjustable; all preamplifier boards are set to the same gain at the factory. The amplified video output is applied to a step down rotary transformer, which drives a balanced cable to the equalizer having a high frequency adjustment, then vided for the output of the sync playback head.

The board also includes some noise filtering for lines between the AST head assembly and the AST Driver PWA (via the scanner slip ring assembly). These lines carry the AST drive and sense signals.

2-213. Record Amplifier PWA

During record mode this PWA amplifies the rf signal from the modulator and applies it to the video record head, and to the sync record head if so equipped. During edit play mode a playback signal is received from the video record head, is amplified, and then is sent to the equalizer. Refer to Figure 2-60. The solid line portion shows the non-sync version, PWA 1400245. The sync version, PWA 1400225, includes both the solid line and dotted line portions.

2-214. Record Mode. The record rf signal is applied to the board through balanced cables. This rf is at twice the carrier frequency, for eliminating second harmonic effects. The signal is first buffered via line receivers which square it for application to divide by two circuits. Following the buffer, identical circuitry is used for the video record and sync record paths (PWA No. 1400225). In either path the divide-by-two output is transformer coupled to a grounded base record amplifier. The amplifier current is controlled by the video (or sync) record level control signal. This command turns the amplifier off during playback. The video record amplifier output is transformer coupled to the record/play switch. The record/play command energizes a relay, switching the record transformer output to the video record output pins J1 and J3. The record signal is passed to the video record head through a rotary transformer. The sync amplifier output is transformer coupled to output pins J4 and J6. The output signal is applied to the sync record head through a rotary transformer.

Resistors and the output transformer secondaries (video and sync), provide impedance voltage dividing. These dividers shape the record currents to the heads to cause roll off with increasing frequency.

During record mode the −12 volt supply is switched to the circuitry by the record/play command.

2-215. Play Mode. In play mode a playback signal from the video record head is switched to a preamp transformer, by the low record/play command. The transformer output is applied to a differential, balanced preamplifier, which is activated by the record/play command. The preamplifier output signal, called record head playback rf, is routed to the Equalizer PWA. This signal is used in an EE edit playback mode.

The low record/play command removes the −12 volt supply from the record drive circuitry during play mode.

2-216. Edit Erase PWA

This PWA provides erase oscillator current to the video edit erase and sync edit erase heads. Refer to Figure 2-61. The oscillators operate at 24 MHz. The frequency is adjustable by means of variable inductances. Each oscillator is switched on by an edit erase command that applies +12 volts via an erase head center tap.

2-217. AUDIO CIRCUIT DESCRIPTION

2-218. General

The audio system provides interfacing and processing for all audio and cue signals. The standard

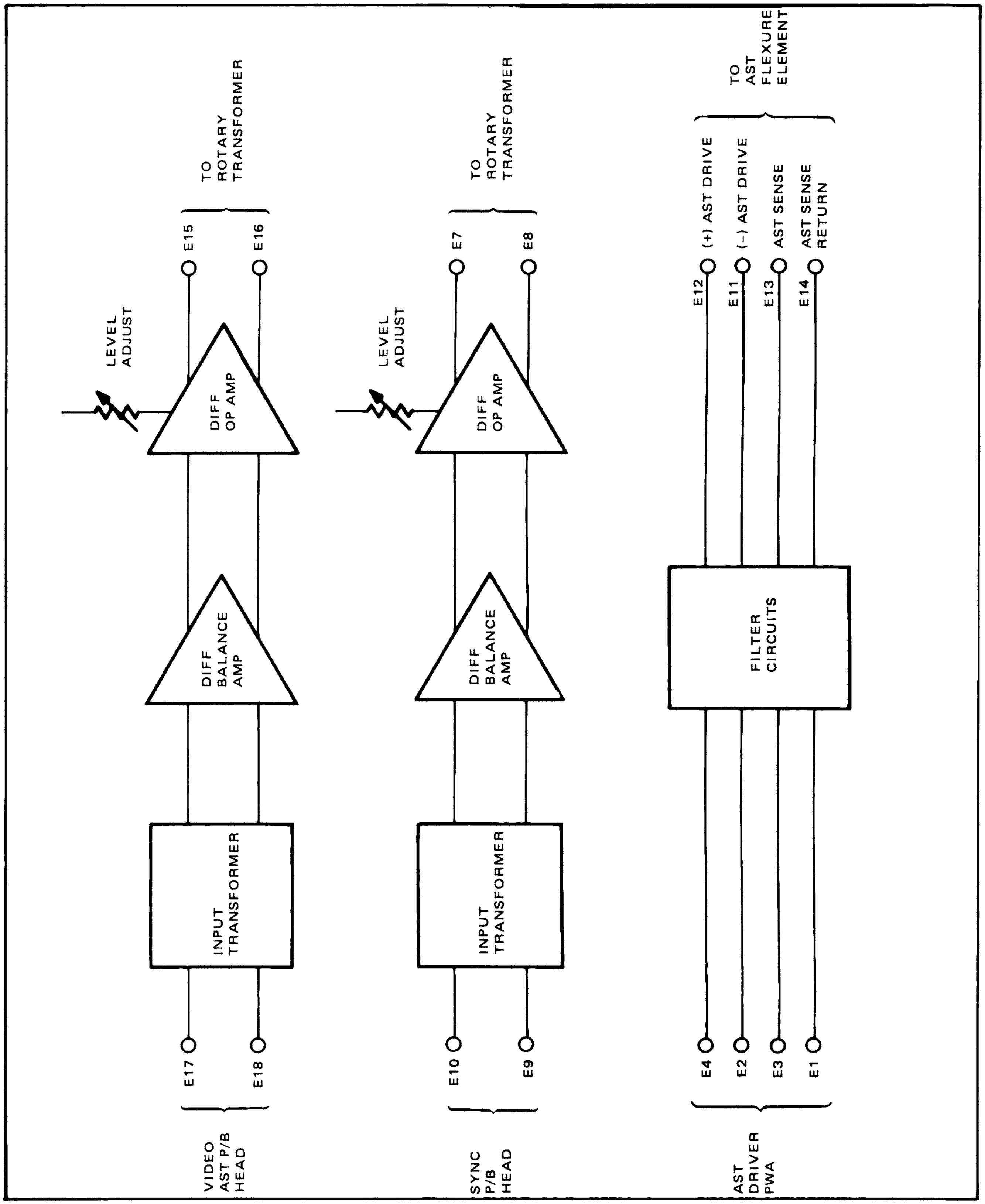


Figure 2-59. Preamplifier Block Diagram

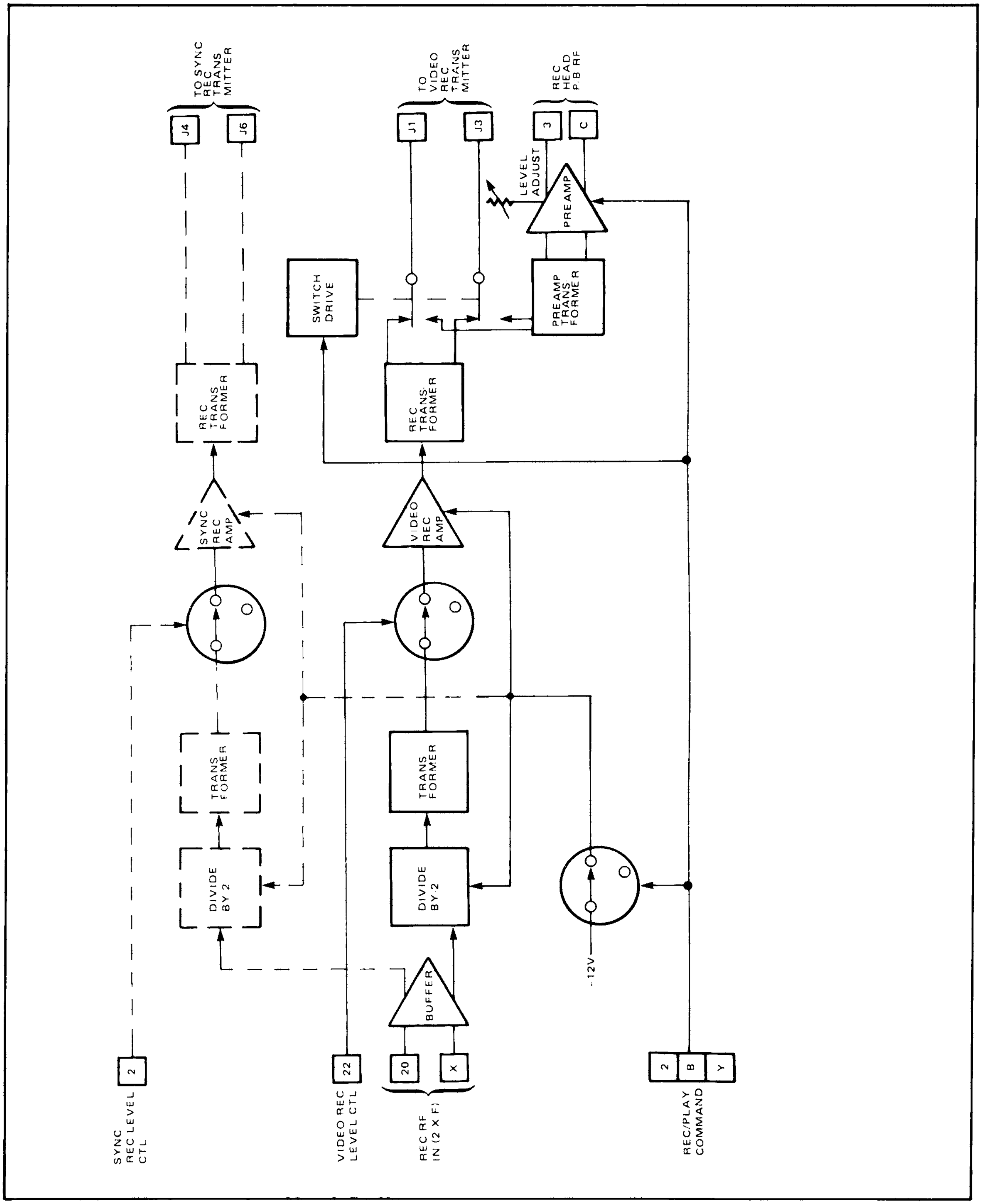


Figure 2-60. Record Amplifier PWA Block Diagram

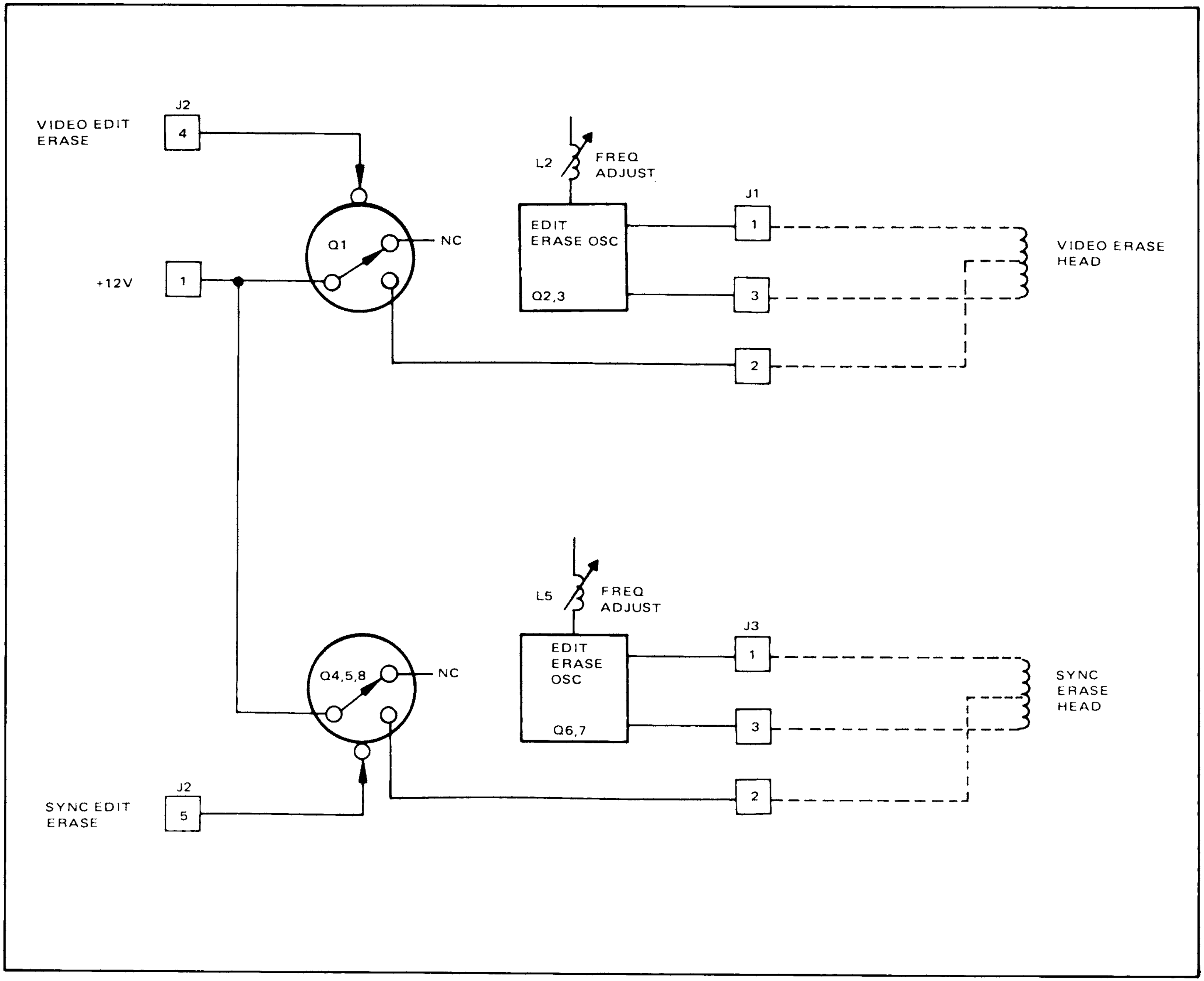


Figure 2-61. Edit Erase PWA Block Diagram

three channel audio system contains six PWA's. Provision is made to accept a seventh PWA for converting to an optional (EBU) four-channel system.

The audio system block diagram, Figure 2-62, shows the main interconnections within the audio system and also shows interfacing signals between the audio system and other sections of the VPR. A standard three channel system is shown in solid lines. Additions needed for a four channel system are shown in dotted lines. The designation "3/4" denotes a channel that is used for channel 3 in a standard audio system and is used for channel 4 in a four channel system.

Refer to Figure 2-62. In record, audio input signals are processed to drive the record/play heads via switching in the Preamp PWA. Bias, video erase and audio erase drive signals are generated in the Bias/Erase PWA. In playback the off tape signals are amplified in the Preamp PWA and further processed in the Audio PWA and Line Driver PWA to provide audio line outputs via the Audio I/O PWA. For an optional four channel system (EBU), the EBU Audio 3 PWA provides all necessary channel 3 functions except those of the Audio I/O PWA.

Descriptions of the audio system PWA's are given in paragraphs 2-119 through 2-234. Also, a functional block diagram is presented for each PWA.

NOTE

Some audio board schematics do not presently designate channel 3 functions as channel "3/4" functions. However, all channel 3 functions of a standard audio system are in fact used for channel 4 functions when an optional four channel system is installed. (The channel switching is provided by selection of one of two connector headers located on the Audio I/O PWA.)

2-219. Bias/Erase PWA No. 1

This PWA processes 125 kHz and 83.3 kHz inputs to supply bias and erase currents as shown in Figures 2-63, 2-64, and 2-65. The board also contains meter drive amplifiers which provide vu or ppm (peak program meter) signals to the audio meters. In addition, there is a wake-up circuit for controlling the relay supply, to prevent record or erasure at power-on and power-off. The bias, erase, and meter drive circuit functions are described in paragraphs 2-220 through 2-222. Refer to schematic diagram 1400015.

2-220. Bias Drive. Refer to Figure 2-63. Three identical bias drive circuits are provided. In each, the 125 kHz signal, an audio record logic signal, and a master bias level are applied to a bias ramp circuit. The ramp is provided by an op amp configuration using capacitive feedback. The square wave output of this circuit ramps to full amplitude gradually enough to prevent the recording of pulses (pops and clicks) at turn-on. The bias is similarly ramped down at turn-off. At the start of ramp up, an audio record out signal is developed and applied to the Audio PWA to enable recording for that channel.

The ramp output is passed through an adjustable tuned filter to an amplifier having a bias level adjustment potentiometer. This bias amplifier is operated in a Class AB configuration to minimize crossover distortion. The amplified output is applied to a series resonant tank circuit that includes a transformer with a peaking adjustment. The output of this resonant circuit is then ac coupled to the record/play head, where it is summed with the record current from the Audio PWA. Test points TP1, TP2 and TP3 are provided for monitoring the record head currents for each of the three channels.

The master bias potentiometer varies the bias amplitude of all audio channels together. This signal is passed off the board for use by the EBU Audio 3 board, in the optional four channel system.

2-221. Erase Drive. Refer to Figure 2-64. Audio erase 1, 2, and 3 control signals from the Control PWA, a video erase signal, and an 83.3 kHz signal are applied to the select logic. The resulting erase drive signal is then fed to one of three identical erase drive circuits.

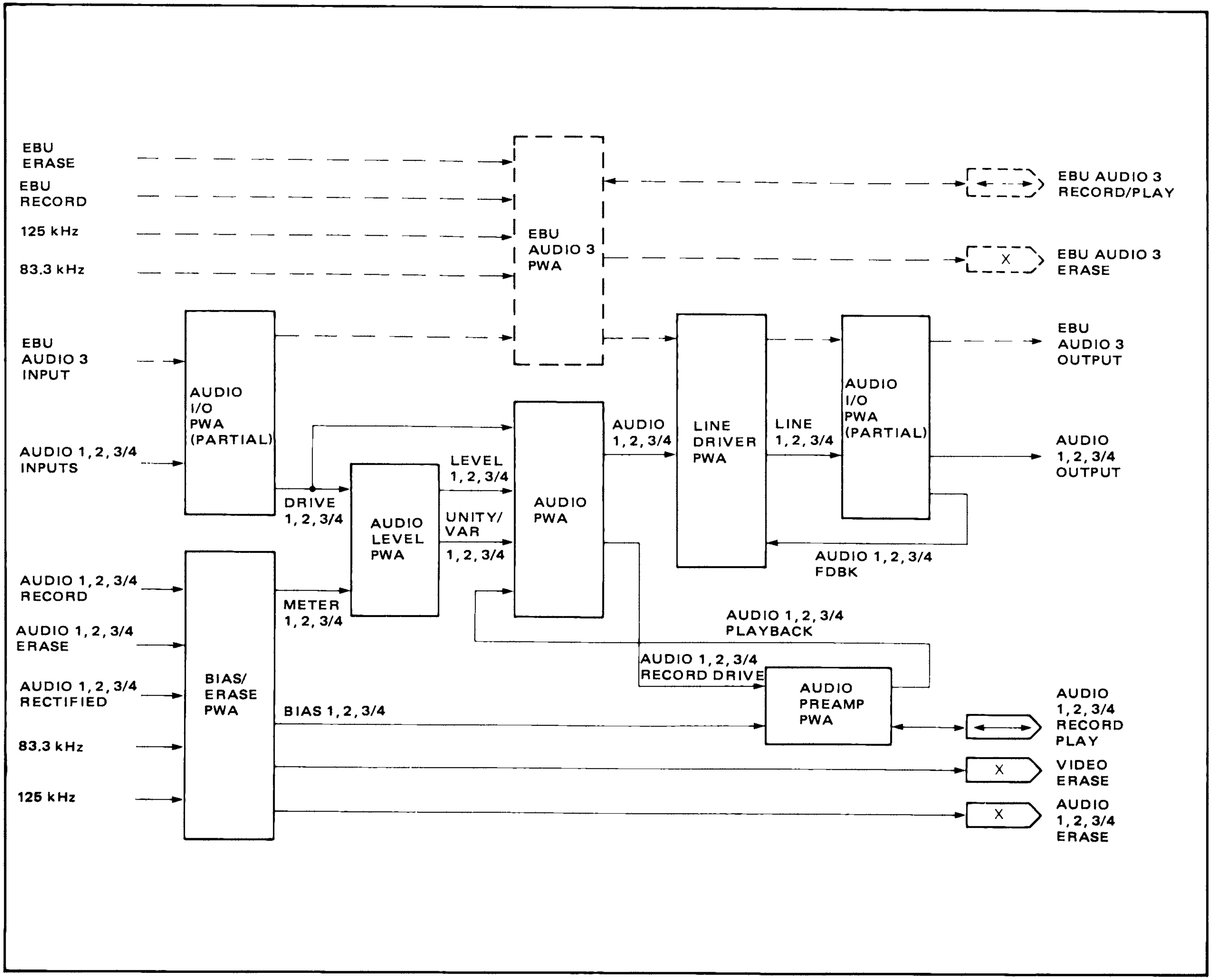


Figure 2-62. Audio System Block Diagram

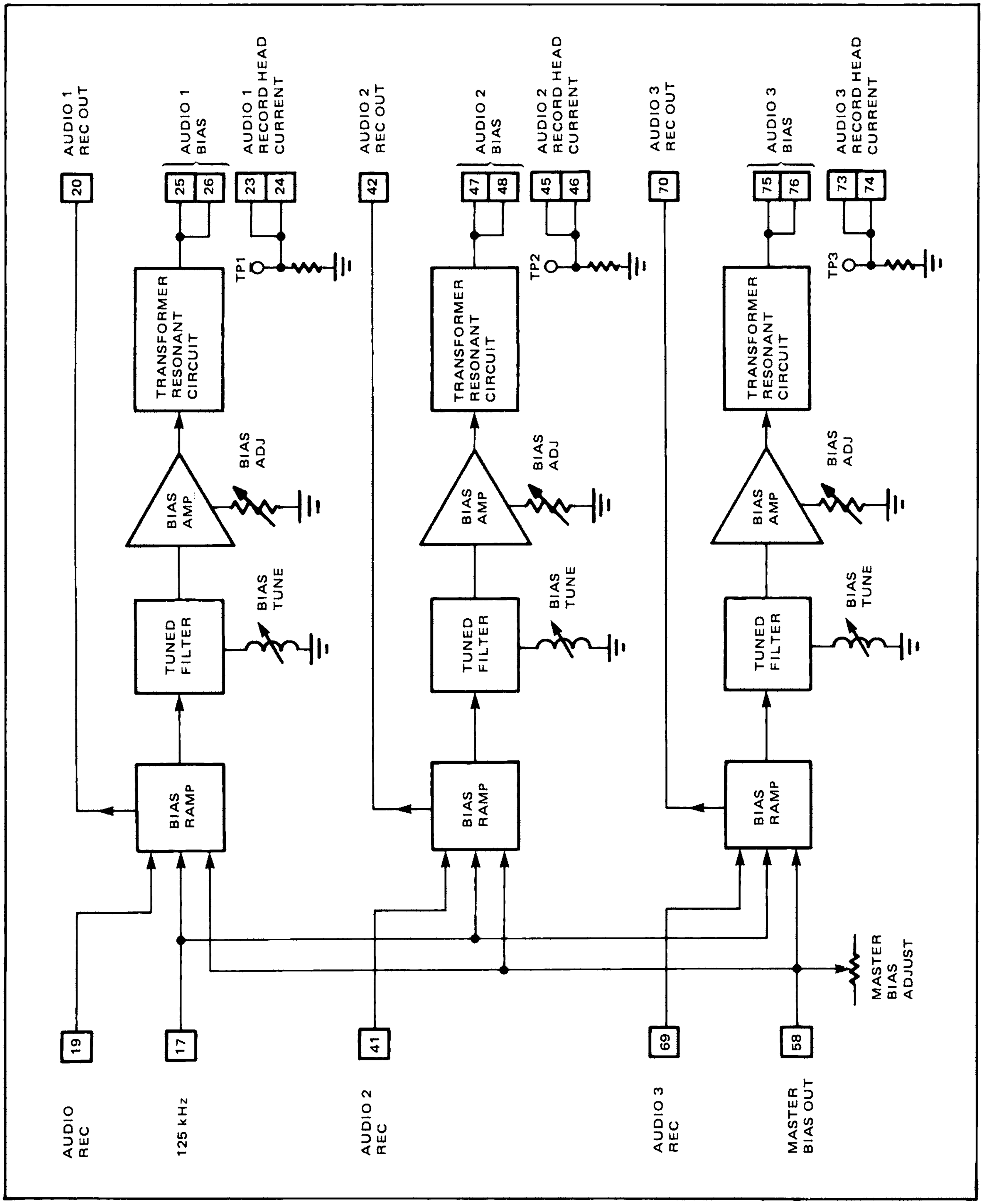


Figure 2-63. Bias/Erase PWA Block Diagram – Audio Bias Section

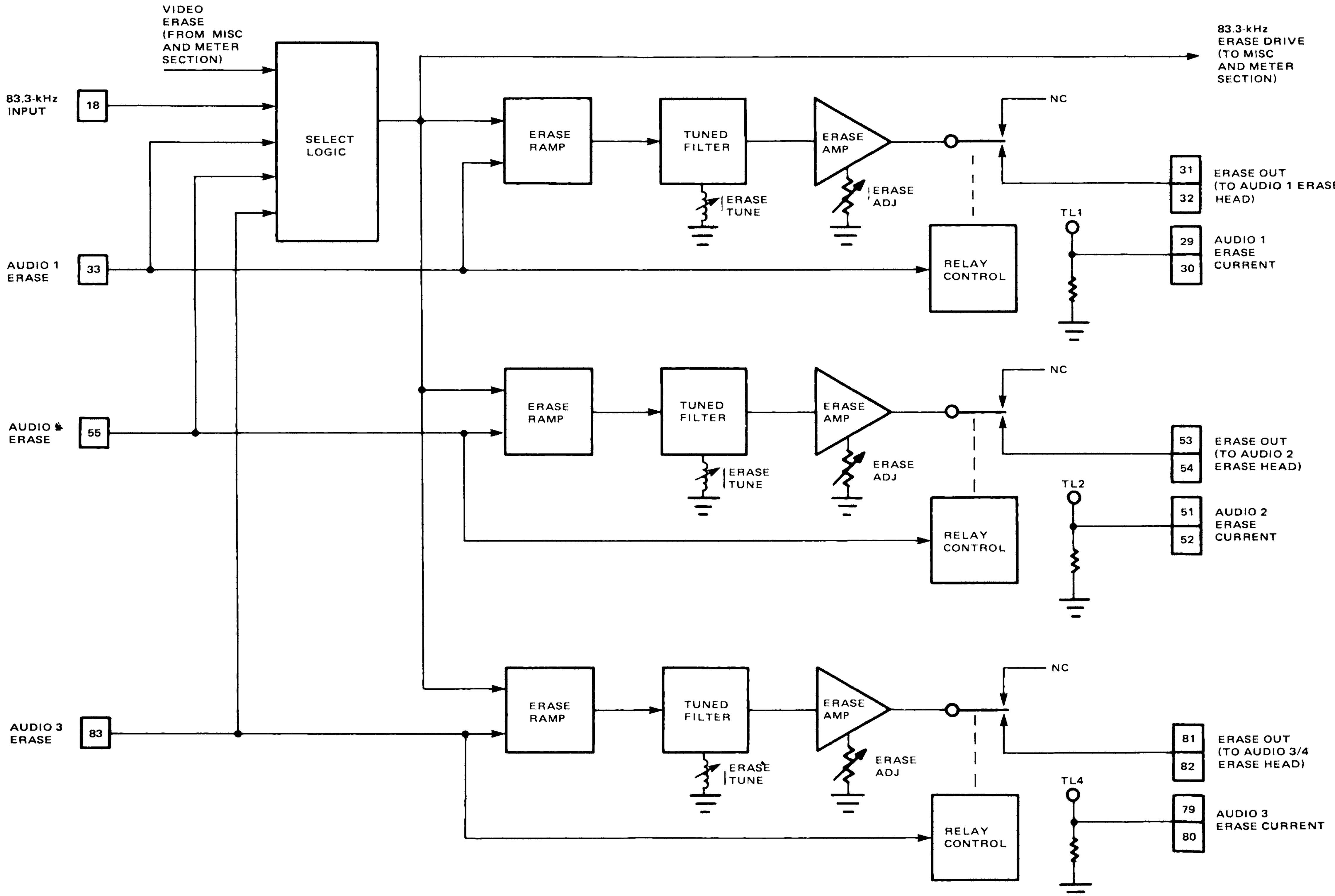


Figure 2-64. Bias/Erase PWA Block Diagram – Audio Erase Section

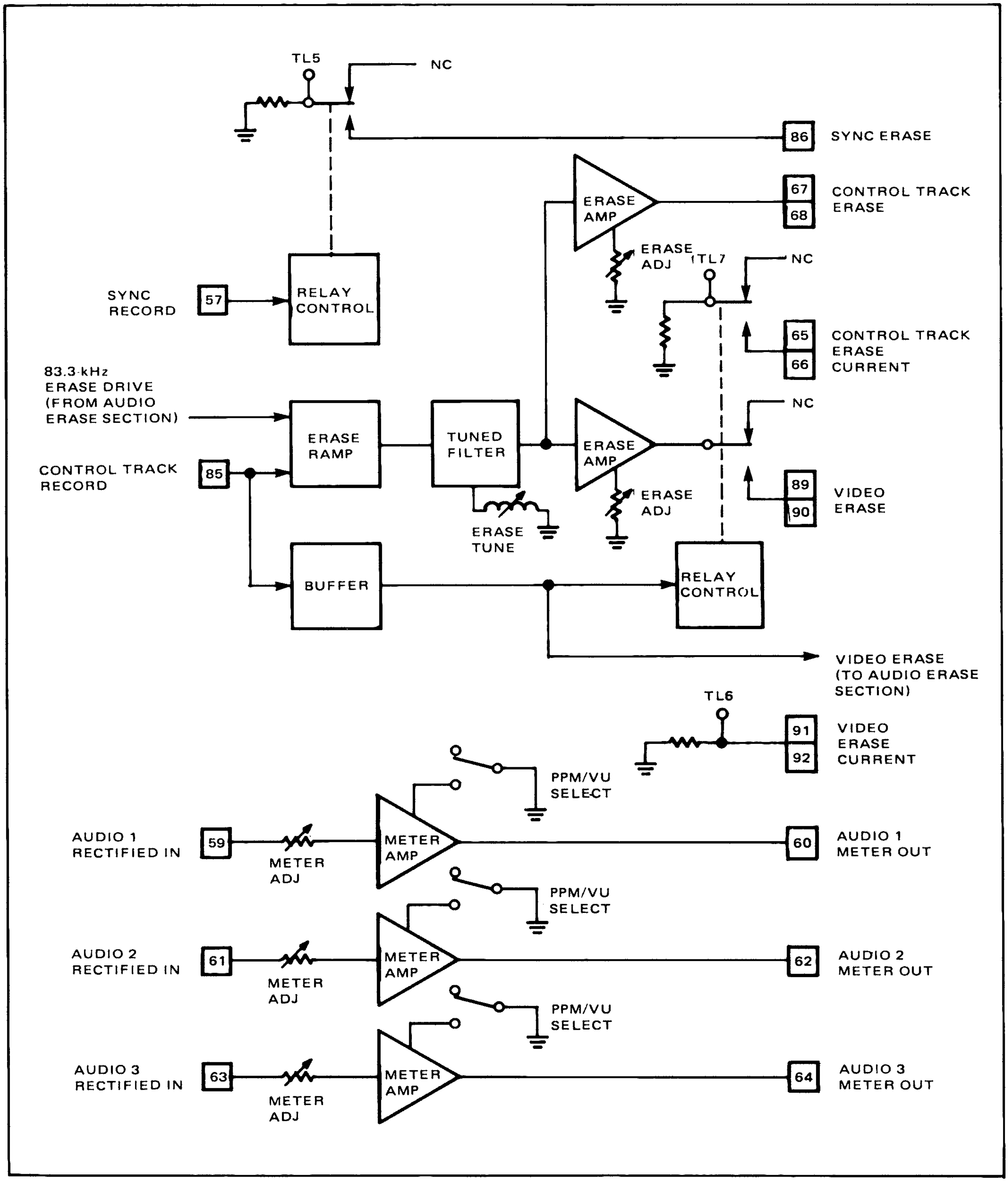


Figure 2-65. Bias/Erase PWA Block Diagram — Miscellaneous and Meter Section

In each of these three circuits, the 83.3 kHz video erase signal and an enabling signal for that channel are applied to an erase ramp circuit. The ramp is provided by an op amp configuration using capacitive feedback. This ramp prevents the recording of pops and clicks at turn-on and turn-off of the erase signal. The ramp output is passed through an adjustable tuned filter to an amplifier having an erase level adjustment potentiometer. This amplifier is operated in a Class B configuration for efficiency. The amplified output is switched by a relay controlled by the audio erase input signal. The amplified output is ac coupled to the board output and passed to the erase head for that channel. The audio erase head provides a high Q inductance which, together with the output coupling capacitor, forms a resonant circuit. Test points TL1, TL2, and TL4 are used for monitoring erase head currents for the three channels.

Refer to Figure 2-65. A control track record signal and the 83.3 kHz erase drive are passed through ramp and tuned filter circuits identical to those of the three audio channels. The tuned filter output then drives two erase amplifiers to provide a control track erase output and a video erase output. These amplifiers have erase level adjustment potentiometers.

The control track erase output is ac coupled to the board output, to drive the control track erase head, located in the audio erase head stack. This circuit is activated in normal record or assemble edit modes. but not in insert edit mode.

The video erase output is switched by a relay actuated from the control track record signal. The output is then ac coupled to the video erase head. Closure of the video erase delay also provides for monitoring of the control track erase current, via test point TL7. The video erase head current may be monitored at TL6.

The sync function is used only for option II of the C format. It must be disabled for an option III system as the audio 4 channel is recorded in the same tape track location as used for sync. The sync erase function is switched by a relay, controlled by a sync record signal from the Control PWA. The sync head erase current is provided by cross-coupling from the video erase head. A capacitor is used in parallel with the sync head inductance to form a resonant circuit. The sync erase current may be monitored at TL5.

2-222. Meter Drive. Figure 2-65 also shows the meter drive function, which consists of three identical circuits. In each, a full wave rectified signal is received from the Line Driver PWA. The input of the meter amplifier uses an op amp configuration that provides the proper response for ppm (peak program meter) ballistic meters. The output configuration of the amplifier is selectable by dip switch S1; when S1 is closed the meter ballistics follow the ppm standard when open the meter ballistics follow the vu meter standards.

2-223. Audio PWA No. 2

Audio channels 1 and 2 of this PWA are identical. Referring to Figure 2-66, these two channels are drawn as mirror images, for showing the crosstalk cancellation interconnections. The audio 3 (3/4) channel is shown in Figure 2-67.

2-224. Record Mode. For either channel 1 or 2, audio signals from the Audio I/O PWA and from the Audio Level PWA are applied to the channel inputs. The unity/variable signal selects one of these two signals, as determined by the push-pull switch associated with the record level control, on the control panel for that channel. If unity is selected, a record calibration adjustment is provided by a potentiometer on the PWA.

The selected input signal is passed throug a 50-kHz low pass input filter and applied to an EE path and to a record path. In the EE path the signal is amplified then switched by means of an EE/Tape signal to the audio line output, via a low pass filter. EE calibration is provided by a potentiometer which varies the gain of the EE amplifier.

The record path, following the 50-kHz input filter, includes a phase pre-distortion network to compensate for non-linearities of the tape recording process. The signal is next passed through a record equalizer having a high frequency adjustment, then through a third harmonic pre-distortion circuit. The op amp feedback path in the pre-distortion circuit uses a diode approximation. A potentiometer adjustment is provided for the pre-distortion level.

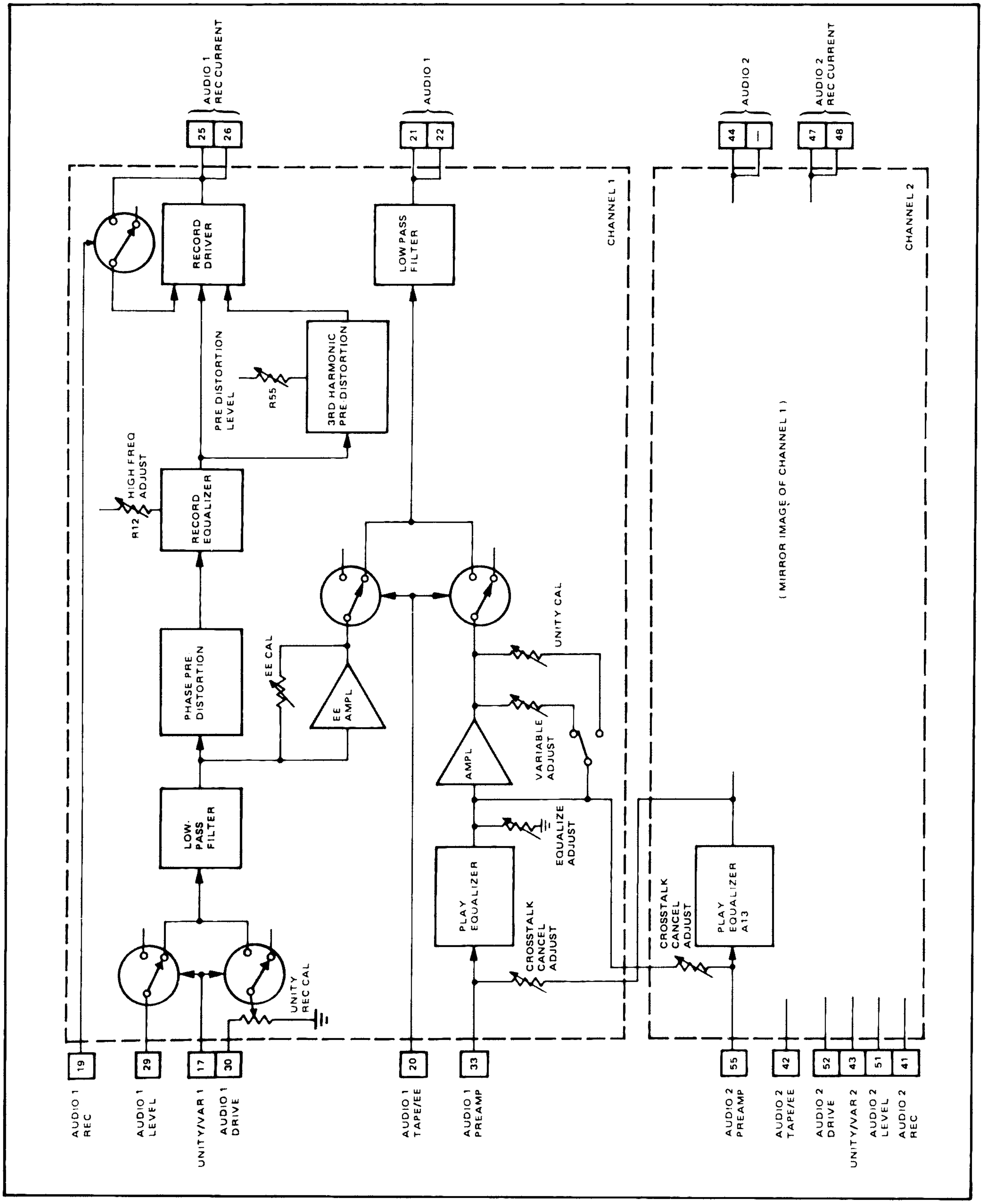


Figure 2-66. Audio PWA Channels 1 and 2

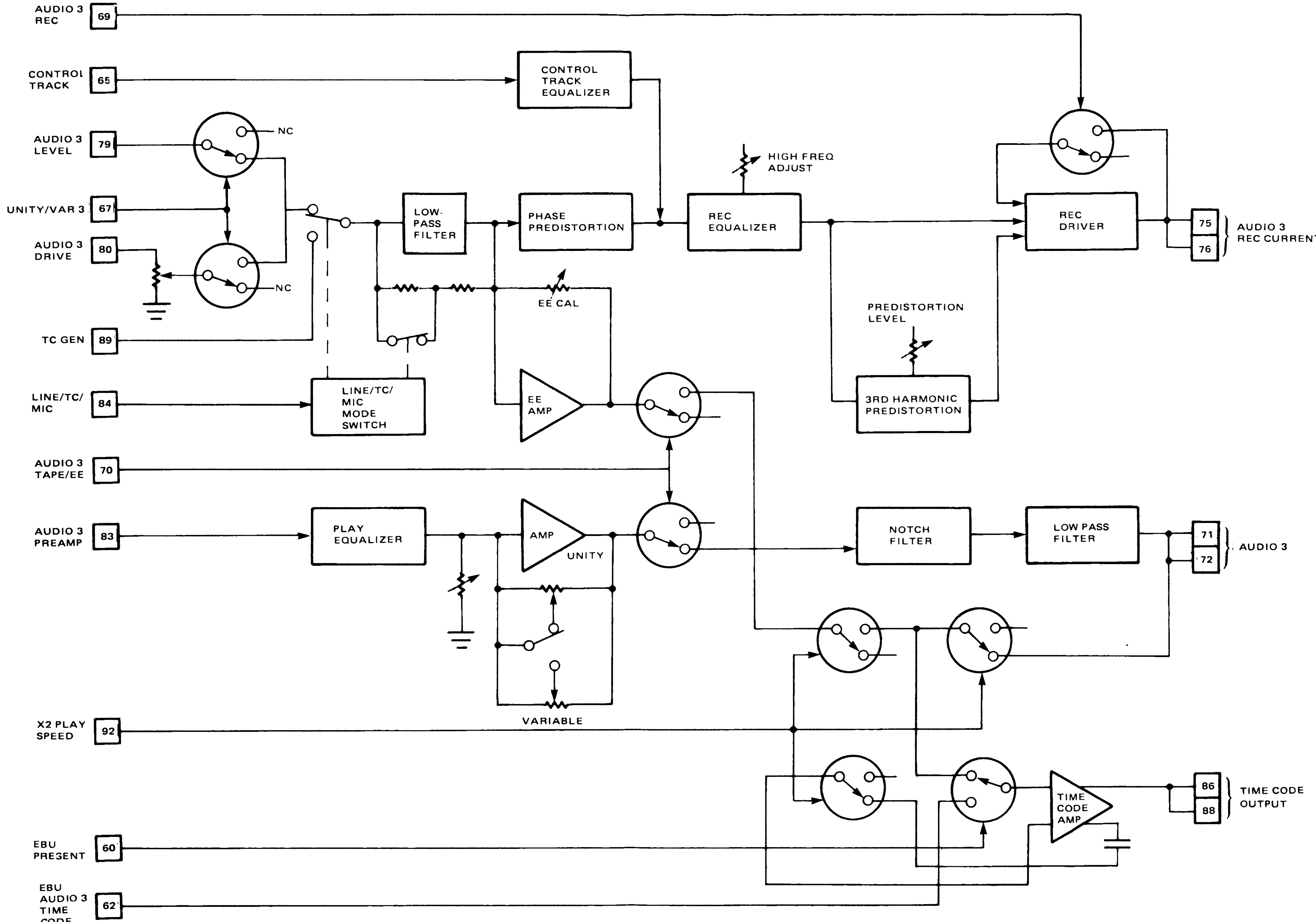


Figure 2-67. Audio PWA Block Diagram – Audio 3 Section

The outputs from the record equalizer and the third harmonic are predistortion circuit are summed at the input of the record driver circuit. A FET switch around the record driver turns it off during playback to eliminate crosstalk to the playback path.

Audio channel 3 (3/4) includes record circuitry identical to that of channels 1 and 2, but has some additional functions. Input signal from the Audio I/O PWA and from the Audio Level PWA are applied to the channel 3 inputs. The selection of one of these signals is determined by the push-pull switch associated with the appropriate record level control on the front panel. Additionally, channel 3 includes switch S4, located on the PWA front panel for selecting one of three modes: line, microphone, and time code. In microphone mode. S4 switches in a high gain configuration. The time code mode is for accepting the optional Time Code Reader Generator PWA.

As in channels 1 and 2, the selected input signal is passed through an input filter (low-pass filter) and applied to an EE path and to a record path. The audio 3 record path includes a circuit for cancelling control track crosstalk. During record, the control track monitor signal is processed and added to the record drive to compensate for control track crosstalk that could otherwise occur during playback. The processing circuitry includes phase pre-distortion and record equalization circuits. A potentiometer is provided for adjusting the control track cancellation. The rest of the record drive circuit is the same as that for channels 1 and 2.

2-225. Playback Mode. Referring to either channel 1 or 2, a low level signal from the audio preamp is passed through a gain stage to the playback equalizer circuit. A potentiometer provides an equalization adjustment. The signal goes through another gain stage to the unity/variable control switch, located on the PWA front panel, then to an EE/tape switch. In playback the signal is switched to a 20 kHz low-pass output filter. (The signal also goes to a switch for inserting it into the record path, for setup purposes.) The audio line output, at 0 dBm, is applied to the Line Driver PWA.

The channel 1 and 2 playback circuitry includes a crosstalk cancellation circuit. (Note: on some version Audio PWA's, this circuitry may be located on the Crosstalk Cancellation PWA mounted to the Audio PWA.) The playback equalizer output of each channel is applied to an inverting input of the equalizer of the other channel. A poteniometer adjustment is provided for each channel to a set a level of inverted playback which just cancels out any playback crosstalk.

The channel 3 playback circuitry is the same as that for channels 1 and 2 except where it includes additional functions. The preamp signal is passed through a gain stage to the playback equalizer and then through another gain stage to the unity/variable control circuit. However, a 30-kHz notch filter (NTSC/PAL-M) is added, ahead of the output low-pass filter. A 24-dB notch is set at the control track fundamental to removing any control than X 2 speeds, a pulse shaping capacitor across the control track crosstalk cancellation circuit to provide an improved signal to noise ratio.

The channel 3 time code output is switched to bypass the notch filter and 20-kHz low-pass filter, to avoid roll-off when at greater than X 2 speeds, as shown in Figure 2-67. At less than X 2 speeds, the signal from the low pass output filter is fed through a time code amplifier and sent to the time code out connector, J19.

If the EBU optional four channel audio system is installed, a 4-channel present signal is active. This switches the time code amplifier to a time code output from the EBU Audio 3 PWA. At greater than X 2 speeds, a pulse shaping capacitor across this amplifier is switched out.

2-226. EBU Audio 3 PWA No. 3

This PWA is used only in the optional EBU four channel system. It provides all essential channel 3 functions. The previous channel 3 circuitry is used for channel 4. Refer to the block diagram, Figure 2-68. The board includes record, play, bias, and erase functions, as well as line/mic/time code mode selection. In addition, the EBU audio 3 board can accept an input from the (optional) Time Code Reader/Generator PWA. A record

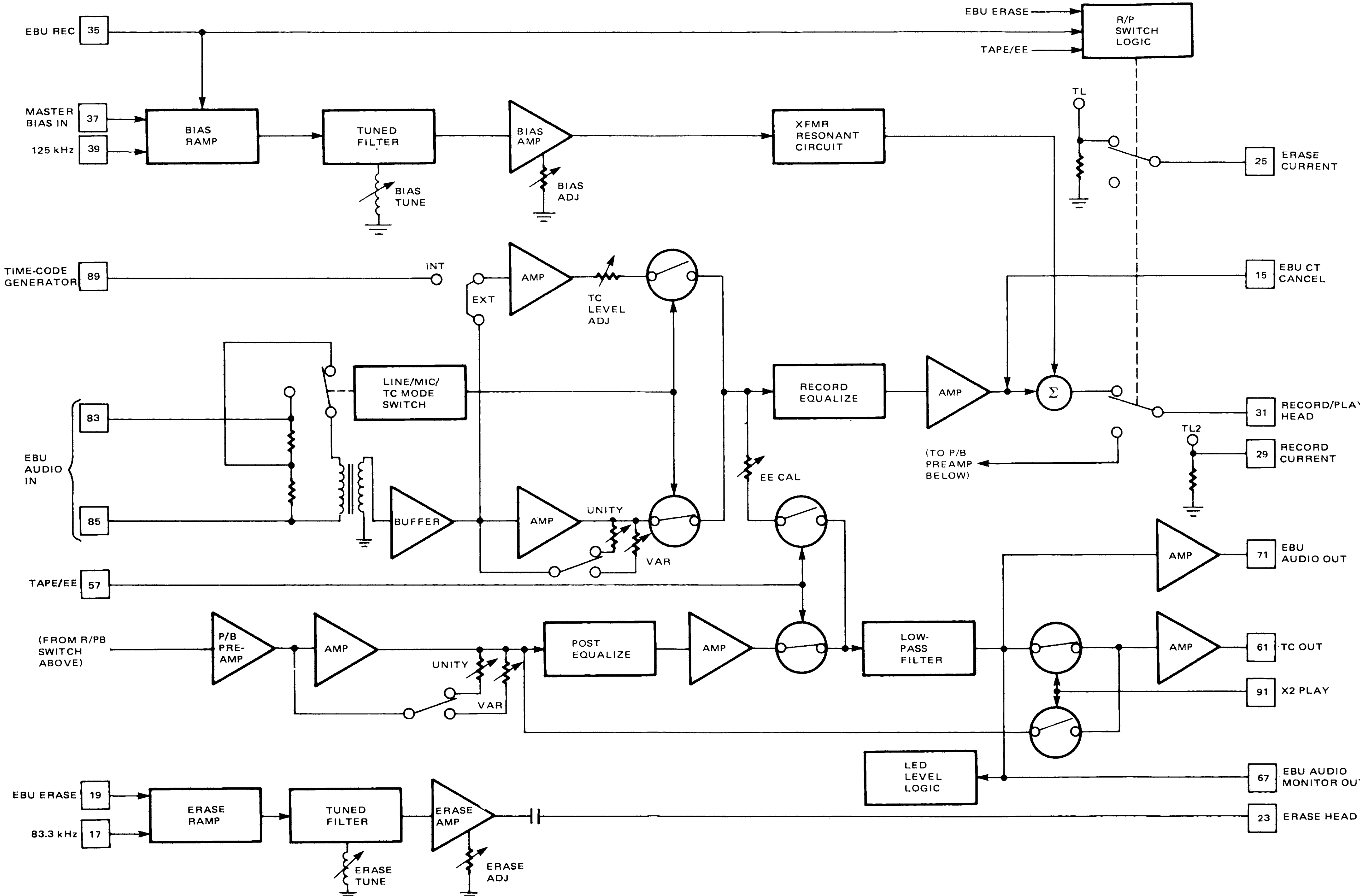


Figure 2-68. EBU Audio 3 PWA Block Diagram

Monitor output is also provided. However, the previous channel 3 meter is shared with channel 4, in a four channel system. The record, bias, erase, and playback functions for this PWA are discussed in paragraphs 2-227 through 2-230. Refer to schematic diagram 1400035.

2-227. Record Mode. The EBU audio input signal is applied to a transformer with a selectable resistance across its primary. Operator switch S3 on the PWA front panel can select line, mic or time code mode. In line mode or time code mode a small portion of a resistance divider is across the primary. In mic mode the full resistance is across the primary. Also, in time code mode, the time code circuitry is switched into the record path in place of the audio circuitry.

The buffered time code output is applied through a jumper (external TC position) to an amplifier having a time code gain adjustment. Or, an internal time code generator may be selected, by jumper (internal TC position). If not in time code mode, the output for recording goes through a unity/variable circuit controlled by operator switch S1.

The selected circuit (time code or audio) applies the signal to record path and to an EE path. In the record path the signal is first passed through an adjustable high frequency record equalizer, then to a record driver. The amplified output goes through a bias trap, then is summed with the bias signal and applied to the record/play head, via the record/play switch. The record/play switch logic consists of a NAND gate requiring high inputs from the bias, bias ramp, erase, and erase ramp signals.

A control track cancellation signal from the Control Track PWA is added to the record signal just ahead of the bias trap. This control track signal compensates for control track crosstalk that could otherwise occur during a playback.

In the EE path, the signal level is adjustable by an EE calibrate potentiometer. A low tape/EE command switches the signal to an amplifier providing low pass filtering. The filtered output is applied to an audio driver stage and to a time code output stage. The EBU audio out signal is passed off the board at pin 71. In time code mode the time code signal at pin 61 is used by the Audio PWA to provide a time code output signal, to rear panel connectors J19 and J10.

2-128. Bias Drive. A 125-kHz square wave is applied to a bias ramp circuit, along with a master bias level and an EBU record command. The ramp is provided by an op amp configuration using capacitive feedback. This ramp prevents the recording of pops and clicks at bias turn-on and turn-off. The ramp output is passed through an adjustable tuned filter to an amplifier having a bias level adjustment. The amplified output is applied to a series resonant circuit that includes a transformer with a peaking adjustment. The output is summed with the record signal.

2-229. Erase Drive. An 83.3-kHz square wave and an EBU erase command are applied to the erase ramp circuit. The erase ramp, tuned filter, and amplifier functions are the same as those for the bias drive. However, the erase amplifier output is applied to an output resonant circuit consisting of a series capacitor and the inductance of the erase head.

2-230. Playback Mode. In playback the off tape signal is passed through a preamplifier circuit which provides playback equalization. It is applied to an amplifier with unity or variable gain, selectable by operator switch S2. The unity and variable potentiometers are adjustable at the PWA front panel. The signal is then fed through a playback post equalization circuit which has a potentiometer adjustment to compensate for head differences. Another stage of amplification is provided just ahead of the tape/EE switching.

In tape mode the signal then passes through an amplifier which provides low pass filtering and is applied to a time code output amplifier and to an audio output amplifier. This filtered output is also used for EBU audio monitoring (pin 67) and for LED signal level indications. The LED logic lights an amber LED for too low a signal level, a green LED for a proper level, and a red LED for a signal approaching, or in, saturation.

At speeds greater than X 2, and X 2 play command switches the signal to bypass the post equalizer/amplifier/low pass filter path. The signal

is applied directly to the time code output amplifier, to prevent time code jitter at high tape speeds.

2-231. Line Driver PWA

This PWA accepts audio 1, 2, and 3/4 signals from the Audio PWA and provides additional current drive. It also includes monitoring and metering circuits. The EBU audio 3 line drive signal is wired straight through the PWA.

Refer to the block diagram, Figure 2-69, and Schematic Diagram 1400202. The three audio inputs connect to switches which may be opened individually or in parallel, by mute signals. With these switches closed, the audio signals are applied to Class AB amplifiers using output drive protection circuits. The outputs are current limited. The amplified audio signals are passed to the Audio I/O PWA, to drive output transformers. Feedback windings on these transformers send feedback 1, 2, and 3/4 signals back to the line driver board, for monitoring and metering purposes.

These feedback signals are applied through switches to voltage gain amplifiers. The amplified outputs, at nominal 0 dBm levels, are routed to the rear connector panel. Remote monitoring outputs are provided for all three channels. Also, a jack is provided for local monitoring of channels 1 and 2. The feedback signals are also applied through switches to voltage gain stages followed by full wave rectifiers. This provides metering signals to the Bias/Erase PWA, which in turn drives the front panel vu, or ppm meters.

Monitor muting and meter muting jumpers are provided. These jumpers allow selection of either the feedback signals or the audio inputs from the Audio PWA, for monitoring and metering.

2-232. Audio I/O PWA

This PWA (Figure 2-70) provides input coupling and amplication for the balanced audio line inputs, and output coupling for the balanced audio line outputs. Additional amplification is provided for channel 3/4 during microphone use. To use this board in a standard three channel audio system (channel 3/4 used for audio 3), P5/6 must be plugged into J5. To use it in the optional four channel EBU system (channel 3/4 used for audio 4), P5/6 must be plugged into J6; the EBU Audio 3 PWA provides channel 3. Refer to schematic diagram 1400205.

In each of channels 1, 2, and 3/4 a high impedance input transformer couples the differential input to a current gain stage. The amplified, single-ended output of each of these channels is then applied to the Audio PWA and to the Audio Level PWA. (All signals internal to the audio system are single-ended, referenced to ground.)

The microphone mode is selected by operator switch S4 on the front panel of the Audio PWA. The switch controls the mic input, pin 21 (J2) of the audio I/O board, to determine switching between the microphone mode, the mic transformer/amplifier path is switched in, in parallel with the channel 3/4 input transformer to provide the additional gain required for microphone use. These parallel currents are summed and applied through a current gain stage to output pin 5 (J2). When the VPR is not in microphone mode the mic transformer inputs are grounded to minimize noise.

The line drive signals, at 0 dBm levels, are applied to output coupling transformers. These transformers provide balanced outputs, at +8 dB levels, to the line out jacks on the rear connector panel. Tertiary windings on these transformers supply feedback signals to the Line Drive PWA for monitoring and metering purposes.

2-233. Audio Level PWA

This PWA provides for operator control of audio record levels for channels 1, 2, and 3/4. Refer to Figure 2-71 and schematic diagram 1400208.

The record level potentiometers, located on the operator control panel, incorporate push-pull switches. The outputs of these switches are applied to the Audio PWA where they control input selection switches. When the channel 1 control is pushed in (unity gain) the output at pin 16 is high; the Audio PWA selects the audio 1 input from the Audio I/O PWA. When pulled out (variable gain) the pin 16 output is low; the Audio PWA selects

the audio 1 input from the Audio Level PWA, allowing control panel adjustment of the level.

Buffer amplifiers are provided between the potentiometers and the Audio PWA. The PWA also includes wiring for the vu, or ppm, meters and sockets for meter lamps DS1 through DS4.

2-234. Audio Preamp PWA

This PWA provides switching of the record and bias currents to the record/play heads during record, and switching of off tape signals to the preamplifier during playback. The mode switching is controlled by relay commands from the Bias/Erase PWA. Refer to Figure 2-72 and schematic diagram 1400217. In play mode, each off tape signal is applied to an integrating preamplifier. For a constant flux level the playback frequency response of the preamplifier is flat.

A harness hardwired to the PWA, plugs into the transport assembly. Also, three 3-pin connectors are mounted on the PWA, one for each audio head.

2-235. POWER SUPPLY CIRCUIT DESCRIPTION

2-236. General

The power supply consists of the power chassis assembly (1400480) and the regulator assembly (1400595). Each assembly includes interconnection harnessing. The regulator assembly consists of the power regulator PWA (1400596) and the heatsink (1400495), on which power transistors (Q001 through Q004 are mounted. The power supply is located at the rear of the VPR above the rear connector panel. The various power supply outputs, and their functions, are listed in Table 2-1.

2-237. Power Chassis Assembly

The power chassis assembly consists of power transformer T1, rectifiers A1, A2, A3, and the associated filter capacitors. Refer to the power supply block diagram, Figure 2-73. Main power (120 Vac or 240 Vac) is applied via the line plug to circuit breaker CB1, located on the control panel. The CB1 switch is designated POWER; it functions as the main power switch.

Transformer primary windings are connected in parallel for 120V operation, and in series of 240V operation. Jumper plugs are used for selecting appropriate input voltage windings within the ranges of 100 through 130 Vac or 200 through 260 Vac. Refer to Table 2-2 for proper line voltage connections. Also, primary winding taps are provided for a remote 120V output and for operating two cooling fans. Most of the transformer secondary outputs are applied to full wave rectifier bridges, and associated filter capacitors. Some unregulated outputs are distributed throughout the machine and some are sent to the power regulator board, which provides regulated +5V, ± 12V and +48V outputs.

2-238. Regulator Assembly. The Power Regulator PWA receives unregulated outputs from the power chassis, and voltage sense signals from the motherboard. The +5V regulator circuit receives a ground sense signal, a +5V sense signal, and a +12V reference signal. An op amp (A4) compares the +5V sense signal with the other two signals, to determine the drive for the +5V power transistor (Q001), for proper +5V regulation.

Current limiting is provided by a second op amp (A8) which determines +5V current via a sensing resistor (R001). Excessive output current causes A8 to decrease the power transistor drive. It does this by controlling the base drive of transistor Q1, which can shunt the output of A4 to ground. As the +5V output current decreases, control returns to A4.

To prevent possible damage to +5V chips, an overvoltage protection circuit is provided. This consists of an SCR/zener network connected to the +5V output. Excessive overvoltage causes buildup of a trigger voltage, and the SCR grounds the +5V output. To reset the circuit, power must be removed from the SCR anode.

The regulator circuits for the other voltage operate in a similar way.

The regulator also has a line-high/line-low sense circuit. This senses the +19V supply to detect when line voltage is too high, or too low, for the regulator to compensate. A high line or low line command is then sent to the Search PWA

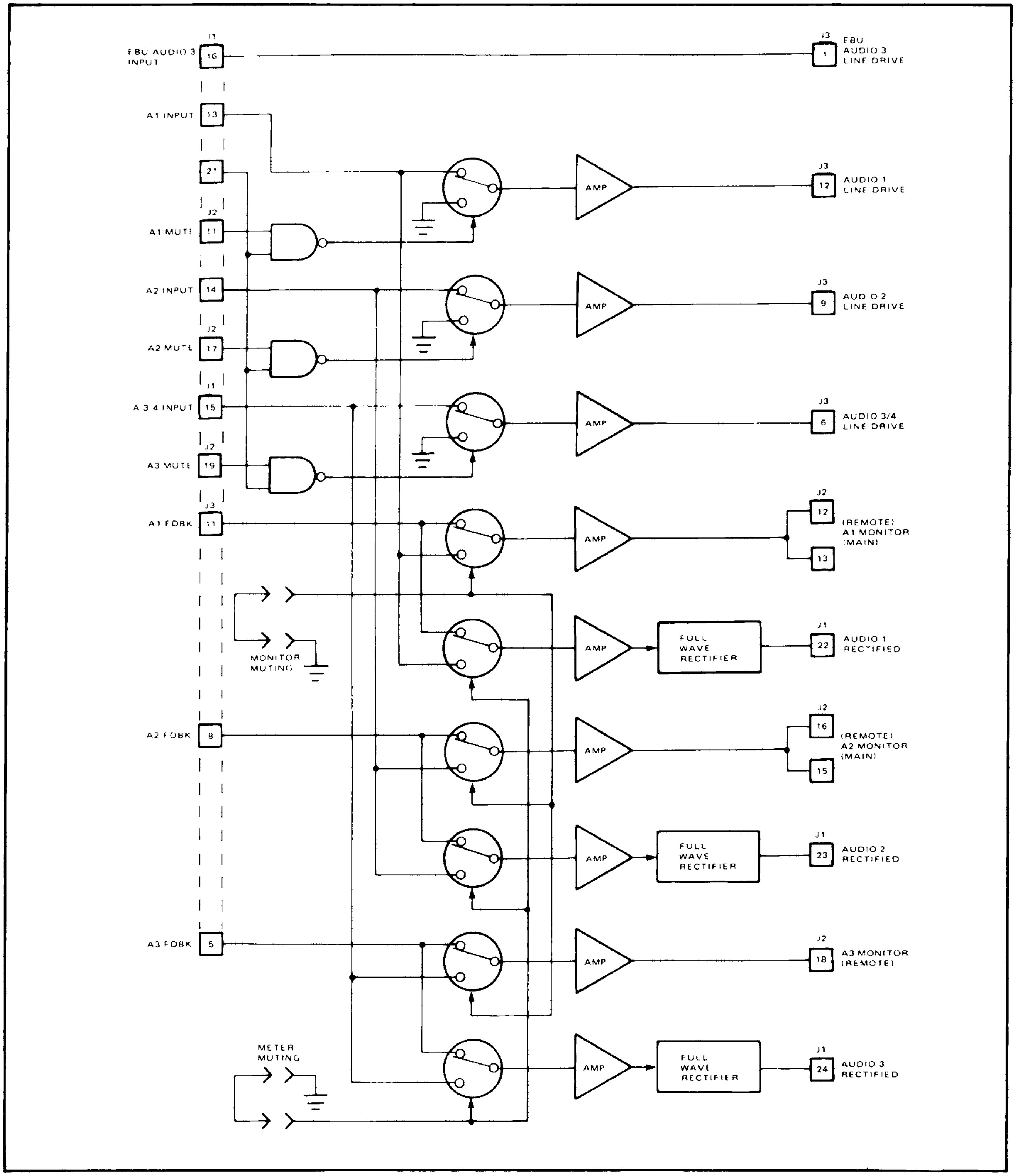


Figure 2-69. Line Driver PWA Block Diagram

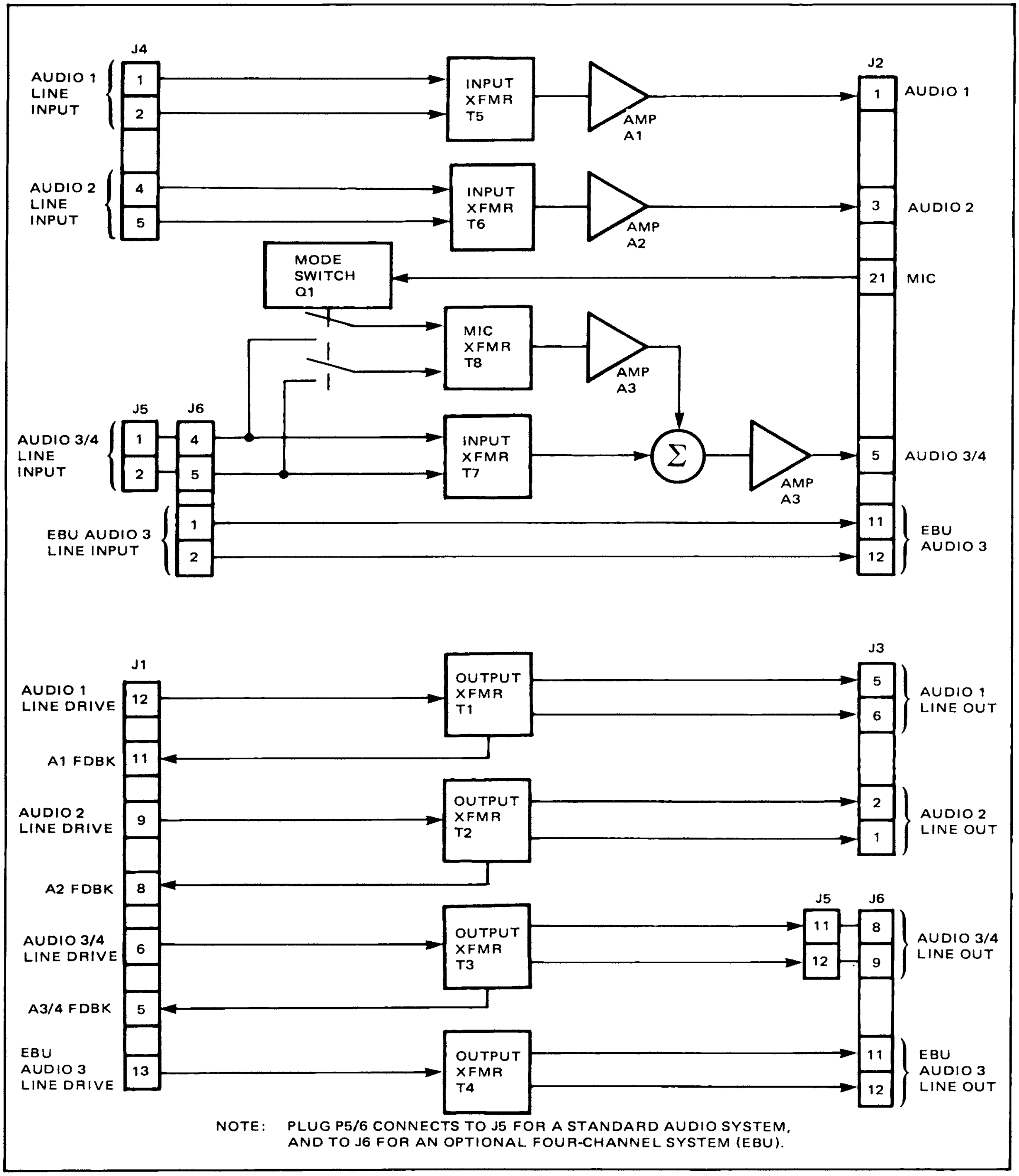


Figure 2-70. Audio Input/Output PWA

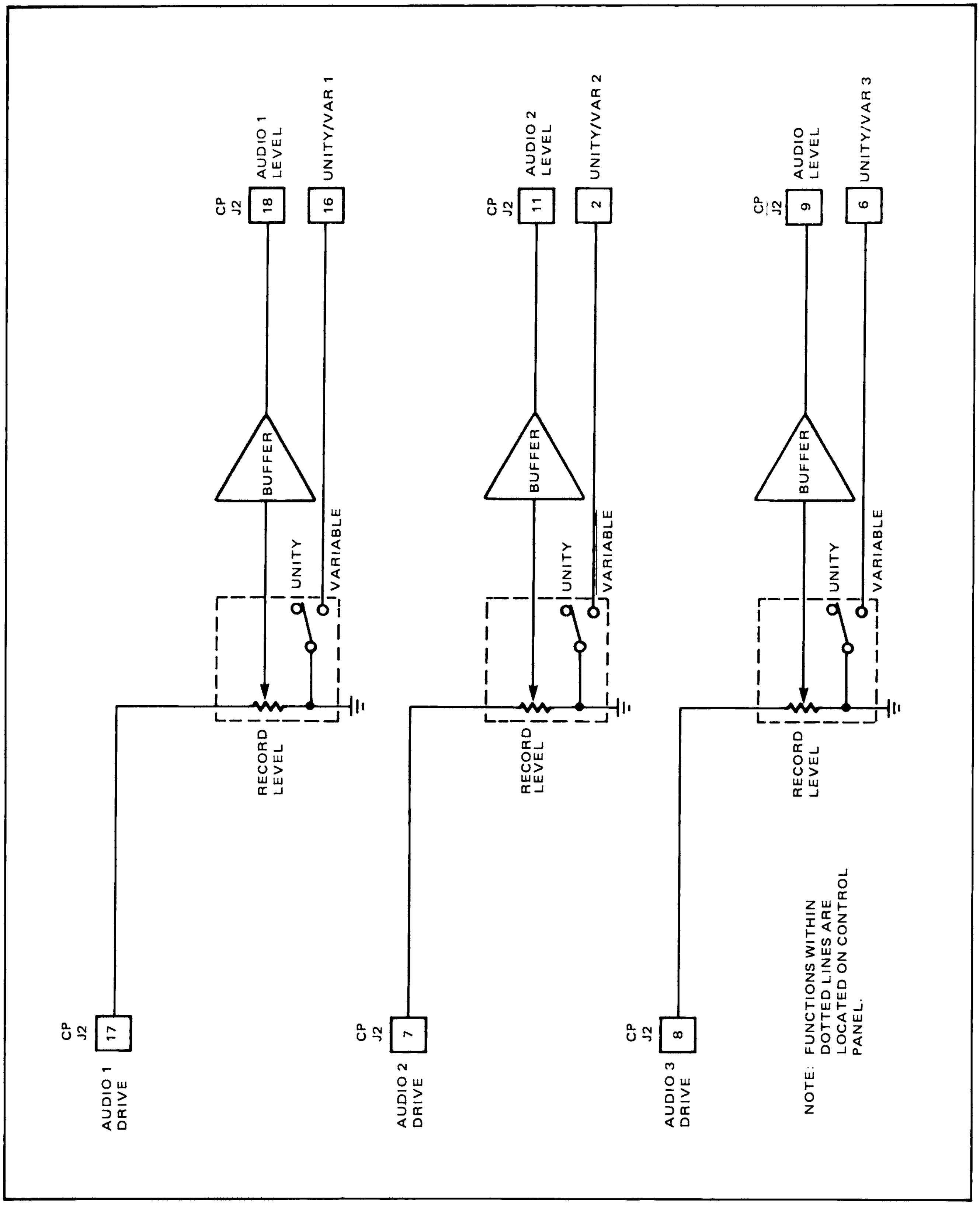


Figure 2-71. Audio Level PWA Block Diagram

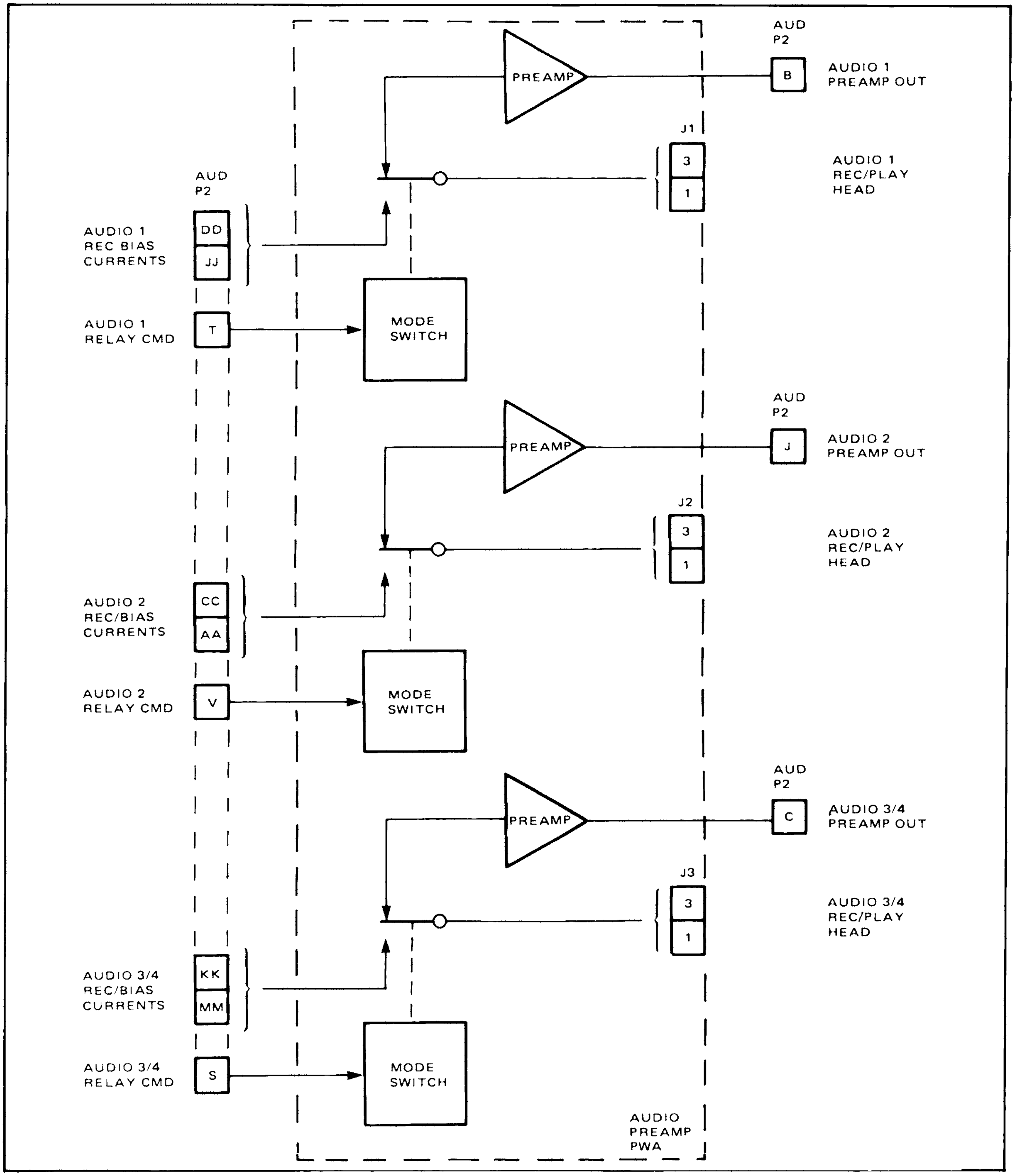


Figure 2-72. Audio Preamplifier PWA Block Diagram

Table 2-1. Power Supply Outputs

OUTPUT VOLTAGE	FUNCTION
+5 Vdc regulated	Provides power to the +5 Vdc electronics bus on the motherboard.
+12 Vdc regulated	Provides power to the +12 Vdc electronics bus on the motherboard.
−12 Vdc regulated	Provides power to the −12 Vdc electronics bus on the motherboard.
+48 Vdc regulated	Not used. Available at J1, pin 20, of regulator assembly.
-6/−12 Vdc unregulated/switched	Provides power to the take-up and supply reel MDA; -6 Vdc non-wind modes, −12 Vdc for wind modes.
+11 Vdc unregulated	Provides +11 Vdc to the take-up and supply reel MDA. Also provides +11 Vdc to the meter lamps, switch lamps, and display drivers on the control panel assembly.
± 19 Vdc unregulated	Provides ± 19 Vdc to the Bias/Erase PWA. Monitored by the line-high/ line-low sense circuit on the power regulator assembly.
+20 Vdc unregulated	Provides +20 Vdc to the capstan MDA and the Scanner MDA.
+48 Vdc unregulated	Provides approximately +58 Vdc to the take-up, supply, and reel brake solenoids pinch roller on the transport.

diagnostic circuitry. This lights a LED on the search board and extinguishes the SYSTEM light on the control panel, to indicate that the VPR systems are not all operating correctly.

The power regulator board also includes a bridge rectifier for the switchable -6V/−12V output. Two legs of the rectifier bridge consist of SCR's controlled by the fast wind command from the Search PWA. A -6V output is produced at normal tape speed, and a −12V output at shuttle speeds.

2-239. Monitor Select PWA. The Monitor Select PWA is located in the monitor bridge and switches which allow selection of video and diagnostic signals displayed by the picture monitor, the vectorscope, and the waveform monitor of the monitor bridge.

Sync, rf, control track, time code, and error signals are conveyed to the monitor bridge's monitor select connector via cable/connector P9 from the VPR. Video signals are carried via coax cables from the VPR's console I/O panel. The Monitor Select PWA plugs into the monitor select connector and allows selection of video to be displayed by means of front edge monitor select switches (see Monitor Select PWA block diagram, Figure 2-74).

Table 2-2. Line Voltage Connections (J1)

LINE VOLTAGE ADJUST	CONNECT PINS		CONNECT PINS		CONNECT PINS		
100	24	23	22	21	15	14	13
110	24	23	22	21	11	10	9
120	24	23	22	21	7	6	5
130	24	23	22	21	3	2	1
200	16	15	14	13	–	–	–
220	12	11	10	9	–	–	–
240	8	7	6	5	–	–	–
260	4	3	2	1	–	–	–

The top and bottom switches are all self-canceling (pressing any button cancels the previous selection) except EXT SYNC which is alternate action. The bottom switch group (except EXT SYNC) preselects video supplied to the picture monitor and vectorscope. This same video is displayed by the waveform monitor if the VIDEO switch of the top switch group is pressed. System diagnostic signals are also available for display by the waveform monitor (top switch group). With the exception of EXT SYNC, pressing any switch supplies ground to the associated switch buffer/amp input. The buffer/amp output closes the associated CMOS switch, passing the selected signal to the monitor amp(s).

Video signals (bottom switch group) pass through video amplifiers before being presented to CMOS video select switches. VIDEO OUT, DEMOD OUT, and VIDEO IN video amplifiers incorporate gain controls, with the latter also having a video dc balance control. Selected video is applied to the pix monitor X 2 amp via a summing point. The summing point allows black clamp sample to be summed with the video. The pix monitor X 2 amp incorporates a gain and a response control. Amplified video is output to the picture monitor and vectorscope. This same video is applied to the video/RF CMOS switch of the upper switch group to be sent to the waveform monitor, if so selected (VIDEO switch is pressed).

The upper switch group operates the same as the lower, except that only RF ENV is amplified (an RF ENVELOPE AMPLITUDE control is included). The selected signal is amplified (Q12, Q11), and RF envelope dc position and set-up ground strobe dc level controls are included. The signal is again amplified by the waveform monitor X 2 amplifier, which incorporates dc position, gain, and response controls. The resulting signal is output to the waveform monitor. Ground strobe reference logic allows ground strobe to display when either the CTL TRACK, SCNR ERROR, AST ERROR, or CT/TC button is pressed.

Ground strobe provides a 0-volt dc reference (calibrated by potentiometer R7) with which to compare AST error or scanner error signal. The ground strobe occurs at reference frame time to allow timing analysis among vertical (reference frame), control track, and time code. Monostable A6 establishes strobe duration, and may be inhibited by insertion of jumper J1, thereby inhibiting ground strobe. Switch Q5, which is enabled when control track is selected, closes the path for the waveform dc position control R13, allowing the waveform dc position to be calibrated.

The remaining half of monostable A6 is triggered by the reference frame signal to provide waveform, monitor sync out which is sent to the waveform monitor.

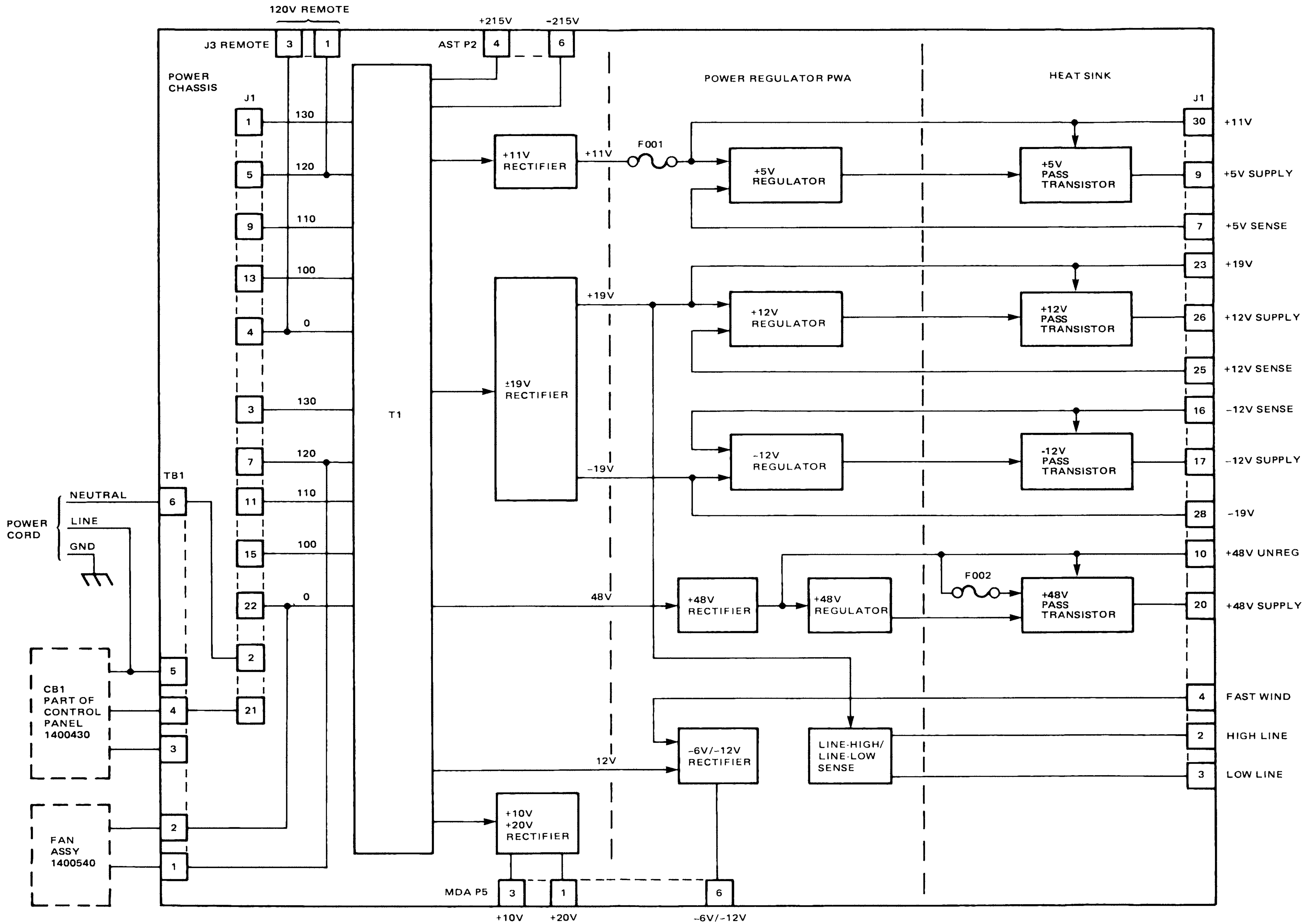


Figure 2-73.
Power Supply Block Diagram

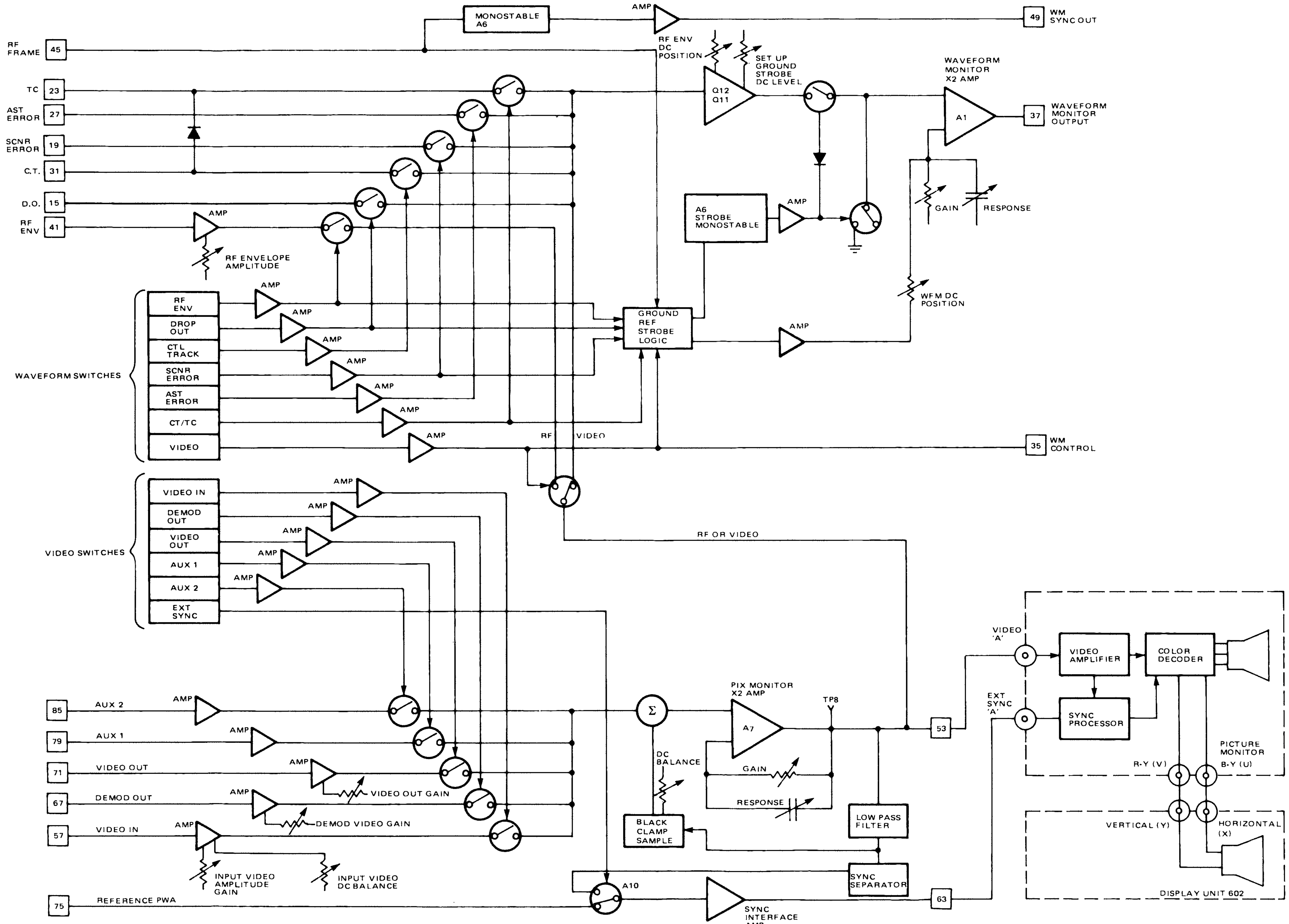


Figure 2-74.
Monitor Select PWA Block Diagram

SECTION 3
MAINTENANCE

3-1. INTRODUCTION

This section of the manual provides procedures for preventive and corrective maintenance. Included are adjustments (mechanical and electrical) and procedures for head and scanner assembly replacement. Also included is a list of test equipment and special tools recommended to maintain the equipment.

3-2. TEST AND MAINTENANCE EQUIPMENT

Electronic and mechanical test equipment and materials suggested for use during testing, alignment, and maintenance of the VPR-2B are listed in Table 3-1. Test equipment with equivalent or better specifications can be substituted for the equipment suggested in the table. Miscellaneous parts and tools that are relatively uncommon and furnished with the VPR-2B are listed in Table 3-2.

3-3. JUMPER AND SWITCH POSITIONING

Jumpers and miniature switches are installed on some of the PWA's in the electronics assembly and on the audio Line Driver PWA to enable selection of color standards, to provide for operation of optional equipment, and to facilitate testing and maintenance.

Table 3-3 provides complete listing of all jumpers and switches. In the event of equipment difficulty, verify that the jumpers or switches are in their "normal" or "desired" position, as listed in Table 3-3.

Table 3-1. Recommended Overall Test and Maintenance Equipment

EQUIPMENT TYPE	SUGGESTED MODEL	USED FOR
Flutter Meter	Micom (Bahrs) Model 8100-W	Measuring transport flutter and tape speed.
AC Voltmeter	Hewlett-Packard Model 400FL or 3400A	Performance check and alignment.
Digital Voltmeter	Hewlett-Packard Model 3435A	General servicing and power supply check.
Frequency Counter	Hewlett-Packard Model 5300A/5302A	Measuring tape speed.
Wideband Oscilloscope with High Gain Preamplifier	Tektronix Model 7603 with 7A13, 7A26, and 7B53A plug-ins	Alignment and servicing.
Current Transformer Probe	Tektronix Model CT-2, Part No. 015-046 mV/mA into 50 ohms	General servicing and adjusting video.
Television Signal Generator	Tektronix Model 147 (NTSC) or Model 148 (PAL) or Model 145-M (PAL-M only)	Video signal system alignment and servicing.

Table 3-1. **Recommended Overall Test and Maintenance Equipment (Continued)**

EQUIPMENT TYPE	SUGGESTED MODEL	USED FOR
Spectrum Analyzer	Hewlett-Packard Model 141T RF Section 8553B IF Section 8552B Tracking Gen. 8443A	Video signal system alignment.
Spectrum Analyzer	Hewlett-Packard Model 3580A	Audio harmonic distortion and erasure check.
Video Noise Meter	Rhode and Schwarz Model BN120312	Measuring video signal-to-noise ratio.
Audio Oscillator	Hewlett-Packard Model 651B or 209A	Performance check and alignment.
Color Picture Monitor	Tektronix 655 NTSC/PAL	Video signal system alignment and servicing.
Vectorscope	Tektronix 520 NTSC	Video signal system alignment and servicing.
Group Delay Meter	Rhode and Schwarz Model BN42392	Video signal system alignment and servicing.
Waveform Monitor	Tektronix 529	Video signal system alignment and servicing.
Storage Scope	Tektronix Model 7313 or other dual trace storage scope	Measuring head-tip projection verifying edit timing.
Tip Projection Gauge	Ampex Part No. 1401000	Measuring head-tip projection verifying edit timing.
Scanner Shipping and Carrying Case	Ampex Part No. 1401347	Shipping scanner assembly.
Head Demagnetizer	Ampex Part No. 4040575	Demagnetizing audio and video heads, tape guides, and capstan (115V operation only).
Bulk Demagnetizer	Taberaser	Demagnetizing trim plates and other large components in tape path.
Head Cleaner	Ampex Part No. 087-007	Cleaning heads, scanner, capstan shaft, and tape guides.
Guide Adjustment Tape—NTSC	Ampex Part No. 1498608	Scanner helical test and alignment.
Guide Adjustment Tape—PAL	Ampex Part No. 1498609	Scanner helical test and alignment.
Flutter Test Tape—525/60	Ampex Part No. 1498602	Measuring transport flutter.
Flutter Test Tape—625/50	Ampex Part No. 1498603	Measuring transport flutter.
Audio Alignment Tape—SMPTE	Ampex Part No. 1498600	Setting operating level and adjusting equalization.
Audio Alignment Tape—EBU	Ampex Part No. 1498601	Setting operating level and adjusting equalization.

Table 3-1. Recommended Overall Test and Maintenance Equipment (Continued)

EQUIPMENT TYPE	SUGGESTED MODEL	USED FOR
EBU Bias Control Track Reference Level Tape	Ampex Part No. 1498614	Record optimization of biased control track head (EBU only).
Precision Plastic Shim Stock; 10 mil, 12 mil	Artus Corp. (10 in. X 20 in. Kit)	Pin-to-scanner gap measurement.
Gram Gauge, –1 grams	Correx Co. Model 475-15	Pin-to-scanner gap measurement.
Tape Tension Gauge	Tentel Model T2-H20-D2, 0 to 20 ounces	Measuring holdback tape tension.
Dial Indicator	Starrett Model 711-HS	Replacing AST brushes.
Feeler Gauge	Starrett Model 467	Measuring various transport clearances.
Spring Scale, 10 pounds (4.54 kg)	Catillon, Model DPP-2500	Pinch roller pressure adjustment.
Gram Gauge, 0–10 grams	Ametek, Hunter Co.	Measure AST brush pressure.
Isopropyl Alcohol—92%	VWR Scientific	Cleaning capstan pinch roller.
Adhesive	Eastman 910, Ampex P/N 018-019	Used when installing new guide spring assembly on entrance or exit guide.
Sandpaper, 400 grit Silicon-Oxide	Norton Co.	Capstan motor brush replacement.
Turbine Oil	Organic base (nonsynthetic) oil. Tresso 47, Socony Mobile Co. DTE Medium	Used when replacing capstan pinch roller.
Soft line-free wipes Cotton swabs, Cotton-tipped swabs	Kimwipes, Ampex P/N 110-015 Q-Tip, Ampex P/N 650-080	Various cleaning and component replacement procedures.
Lacing cord or twine, rubber bands	Ampex P/N 296-004	Capstan pinch roller pressure adjustment.
Brake Gauge Bracket Capstan Top Gauge Bracket	Ampex P/N 1400532 Ampex P/N 1400542	Capstan parts and capstan brake assembly replacement.
Brush Separator (plastic)	Ampex P/N 1408197	For installing AST brushes.
Locator-brush housing	Ampex P/N 1408148	For installing AST brushes.

Table 3-2. **Furnished Miscellaneous Parts and Tools (Ampex Part No. 1400006)**

DESCRIPTION	AMPEX PART NO.	USED FOR
Extender Board	1400228	Extending electronic assembly PWA's.
Takeup Reel	102-117	Transport takeup reel.
Interconnect Cable, TBC-2B	1378507	Interconnect VPR-2B with TBC-2B.
Fuse, 15A, Slow Blow (5 each)	070-431	F001 on power regulator heat sink.
Fuse, 1.5A, Fast Blow (5 each)	070-012	F002 on power regulator heat sink.
Fuse, 1/32A (5 each)	070-409	F1 and F2 on AST Driver PWA.
Lamp, Incandescent, 14V (10 each)	060-407	Control panel lamps.
Shorting Plug (10 each)	602-044	Jumpers on PWA's.
Connector Plug 4 Position	166-324	For fabricating AUTO PLAY connector.
Connector Plug 75 Position	166-859	For fabricating REMOTE connector.
Contact Pin, 24-26 AWG (75 each)	166-226	For REMOTE connector.
Contact Pin, 16-18 AWG (10 each)	166-227	For REMOTE connector.
Extractor Tool	169-616	Extracting Burndy type pins and contacts.
Extractor Tool	167-681	Extracting Amp type pins and contacts.
Snap Lock Tool Handle	360-445	Servicing transport components.
Hex Key Screwdriver Tool, 0.094 A.F.	360-446	Servicing transport components.
Ball Ended Hex Key Screwdriver Tool, 0.109 A.F.	360-448	Servicing transport components.
Ball Ended Hex Key Screwdriver Tool, 0.140 A.F.	360-449	Servicing transport components.
Leg Set Assembly, Scanner Service	1401302	Supporting scanner assembly when removed from transport for servicing.

Table 3-3. Jumper and Switch Positions

PWA	JUMPER/ SWITCH	POSITION	FUNCTION
1 Bias Erase Assy 1400013	J1		Erase drive capacitor selection
		B–C	4 Channel erase stack
		B–A	3 Channel erase stack
	S1		Five-section switch module (only three sections are utilized); used to select audio meter deflection standard; either vu or peak program
	S1-1		Audio channel 1 vu or peak program meter select
		Open	VU (SMPTE)
		Closed	Peak program (EBU)
	S1-2		Audio channel 2 vu or peak program meter select
		Open	VU (SMPTE)
		Closed	Peak program (EBU)
	S1-3		Audio channel 3 vu or peak program meter select
		Open	VU (SMPTE)
		Closed	Peak program (EBU)
2 Audio Assy 1400026	J1		Low-frequency equalization
		A–B	SMPTE
		B–C	EBU
	J2		Rec preamplifier gain audio channel 1
		B–C	Normal
		A–C	+16 dB gain
	J3		Predistortion setup
		B–C	Normal
		A–B	Setup
	J4		Rec preamplifier gain audio channel 2
		B–C	Normal
		A–C	+16 dB gain
	J5		Rec Preamplifier gain audio channel 3
		B–C	Normal
		A–C	+16 dB gain
	J6		Time-code output source select
		A–B	Routes restored TC to remote output
		B–C	Routes off tape TC to remote output
	J7		Control-track cancellation
		A–B	EBU
		B–C	SMPTE
	S1	Unity (up)	Normal. Calibrated playback level audio 1.
		Variable (down)	Operator adjustable playback level audio 1.

Table 3-3. Jumper and Switch Positions (Continued)

PWA	JUMPER/ SWITCH	POSITION	FUNCTION
2 Audio Assy 1400026 (Continued)	S2	Unity (up) Variable (down)	Normal. Same as S1 for audio 2. Same as S1 for audio 2.
	S3	Unity (up) Variable (down)	Normal. Same as S1 for audio 3. Same as S1 for audio 3.
	S4	Line (up) Mic (middle) Time code (down)	Normal. Selects line level mode for audio 3. Selects microphone level mode for audio 3. Selects time code mode operation for audio 3.
3 EBU Audio 3 Assy 1400033	J1	 A–B B–C	Time-code—source External Internal — Time Code Reader/Generator
4 Equalizer 525 Sync Assy 1400040 and Equalizer 625 Sync Assy 1400043	J1	 A–B A–C	Response adjustment selection (sync and video) Normal—individual response adjustment Common response adjustment
	J2	 A–B A–C	Differential phase bypass Normal Setup
	J4	 A–B A–C	Output filter setup Normal Test
	J5	 A–B A–C	Equalizer frequency response setup Normal Test—flat response
	J7	 A–B A–C	Cosine equalizer II setup Normal Setup
	J8	 A–B A–C	AGC inhibit Normal—AGC AGC inhibit
	J10	 Out In	Differential gain bypass Normal Test—flat response
	J12	 A–B A–C	Input filter alignment setup Normal Test

Table 3-3. Jumper and Switch Positions (Continued)

PWA	JUMPER/ SWITCH	POSITION	FUNCTION
4 Equalizer 525 Sync Assy 1400040 (Continued)	J13		Cosine equalizer I setup
		A–B	Normal
		A–C	Test
	J14		Cosine equalizer I setup
		In	Normal
		Out	Test—flat response
	J15		Input filter equalizer setup
		Out	Normal
		In	Test
	J16		Input filter equalizer V setup
		In	Normal
		Out	Test
	S1	Auto (up)	Normal. Enables automatic chroma gain mode.
		Manual (down)	Enables video equalizer and sync equalize potentiometers.
4 Equalizer Non-Sync 525 Assy 1401040 and Equalizer Non-Sync 625 Assy 1401043	J1		Differential phase bypass
		A–B	Normal
		A–C	Setup
	J3		Output filter setup
		A–B	Normal
		A–C	Test
	J4		Equalizer frequency response setup
		A–B	Normal
		A–C	Test flat response
	J6		Cosine equalizer II setup
		A–B	Normal
		A–C	Setup
	J7		AGC inhibit
		A–B	Normal
		A–C	AGC inhibit
	J9		Differential gain bypass
		Out	Normal
		In	Test flat response
	J11		Cosine equalizer I setup
		A–B	Normal
		A–C	Test
	J12		Input filter equalizer V setup
		Out	Normal
		In	Test

Table 3-3. Jumper and Switch Positions (Continued)

PWA	JUMPER/ SWITCH	POSITION	FUNCTION
4 Equalizer Non-Sync 525 Assy 1401040 and Equalizer Non-Sync 625 Assy 1401043 (Continued)	J13		Input filter alignment setup
		A–B	Normal
		A–C	Test
	J14		Factory test jumper
		In	Normal
		Out	Test
	J15		Input filter equalizer setup
		In	Normal
		Out	Test
	S1	Auto (up)	Normal. Enables automatic chroma gain mode.
		Manual (down)	Enables video equalize and sync equalize potentiometers.
5 Demodulator 525 Assy 1401050 and Demodulator 625 Assembly 1401053	J1, J5, J6, J7, J9, J11, J13		Low-pass filter setup
		In	Normal
		Out	Test
	J10, J12, J14		Low-pass filter setup
		Out	Normal
		In	Test
	J2, J3		Low-pass filter setup
		A–B	Normal
		A–C	Test
	J8		Feedback clamp
		In	Normal
		Out	Test and troubleshooting
	J15		Dropout clamp inhibit
		In	Normal
		Out	Inhibit
	J16		De-emphasis inhibit
		In	Normal
		Out	Test—flat response
	S1	Unity (up)	Normal. Provides a unity calibrated chroma level.
		Variable (down)	Enables the chroma level potentiometer when chroma auto/manual switch is in the auto position.
6 Modulator 525 Assy 1400060 and Modulator 625 Assembly 1400063	J1		Pre-emphasis inhibit
		In	Normal
		Out	Test—flat response
	J2		Video input select
		A–B	Normal—differential
		A–C	Single ended
		A–D	Floating—differential

Table 3-3. Jumper and Switch Positions (Continued)

PWA	JUMPER/ SWITCH	POSITION	FUNCTION
6 Modulator 525 Assy 1400060 and Modulator 625 Assy 1400063 (Continued)	J3		DC clamp inhibit
		In	Normal
		Out	Test
	J4		AFC clamp inhibit
		In	Normal
		Out	Test
	J5, J6		Input amplifier setup
		A-B	Normal
		A-C	Test
7 Character Generator Assy 1400073	S1		Character size
		1	Small
		2	Medium small
		3	Normal medium
		4	Large
		5	Off
		6	Off
	S2	Border (left) Window (right)	Normal
	S3	Black (left) White (right)	Normal
8 Playback Sync Non-AST Assy 1400083	J1		Enables or inhibits use of sync option control S1.
		A-B	Enables S1
		A-C	Inhibits S1
	J2		Playback rf ignore
		A-B	Normal
		A-C	Test
	S1	On (up)	Normal. Enables sync head playback mode.
		Off (down)	Disables sync head playback mode.
8 Playback Sync Processor AST Assy 1400086	J1		Enables or inhibits use of sync option switch S1.
		A-B	Enables S1
		A-C	Inhibits S1 (same as S1 off)
	J2		Vertical sync detector
		In	Normal
		Out	Test
	J3		Playback rf ignore
		A-B	Normal
		A-C	Test and troubleshooting

Table 3-3. Jumper and Switch Positions (Continued)

PWA	JUMPER/ SWITCH	POSITION	FUNCTION
8 Playback Sync Processor AST (Continued)	S1	On (up) Off (down)	Normal. Enables sync head playback mode. Disables sync head playback.
9 AST Servo Assy 1400093	J1	 A–B B–C	AST head setup Normal Test—sine wave Test—sawtooth
	J2	 A–B A–C	Servo loop setup Normal Test
	J3	 A–B B–C	Damping loop setup Normal Test
	J4	 In Out	Servo correction output Normal Test
	J5	 In Out	Detector output Normal Test
	S1	On (up) Off (down)	Enables AST Normal. Disables AST
10 AST Filter Assy 1400100	J1	 C–B C–A	Filter tuning set-up Normal Test
	J2	 A–B B–C	Video standard select 60 Hz 50 Hz
	J3	 A–B B–C	Four-line center setup Normal Test
	S1	Normal (up) Extended (down)	Normal. Selects normal AST lock-up mode Extends AST lock-up range. (For playing back defective tapes.)
11 Scanner Servo Assy 1400113	J1	 In Out	Scanner drive setup Normal Test
	J2	 A–B A–C	Slow-motion vertical servo enable Slo-mo vertical servo enabled Disabled

Table 3-3. Jumper and Switch Positions (Continued)

PWA	JUMPER/ SWITCH	POSITION	FUNCTION
11 Scanner Servo Assy 1400113 (Continued)	S1	Auto (up)	Normal. Scanner vertically locks to off tape signal.
		Tach (down)	Scanner is in tach lock servo only (an abnormal condition).
12 Reference Assy 1400123	J1		Oscillator output
		A–B	Normal
		A–C	Test
	J2		Field edit select
		A–B	Field 2, edit
		B–C	Field 1, edit
	J4		Evaluate video record operation
		Norm	Normal
		Alt	Alternate—video record on every other frame
		On	On—jams on even with scanner off
	J5		Video standard select
		A–B	60 Hz
		A–C	50 Hz
	S1	Auto	Normal. Automatically selects either video input timing or external timing reference.
		Ref	Selects external source only.
		Video	Selects video input source only.
	S2	1–15	Allows adjustment of servo/TBC lead in 1/2-line increments up to 7-1/2 lines.
		13	Normal
13 Color Framer NTSC Assy 1400130	J1		Remote control permit.
		A–B	Permit
		B–C	Inhibit
	S1	On	Normal. Enables color framer in all playback modes.
		Edit	Enables color framer only during assemble and insert edit modes.
		Off	Disables color framer in all playback modes.
	S2	Normal	Normal. Selects playback phase.
		Invert	Reverses normal playback phase.
13 Color Framer PAL/SECAM Assy 1400133	J1		Remote control permit.
		A–B	Permit
		C–A	Inhibit
	J3		7.8-kHz phase select
		A–B	Normal
		A–C	Invert

Table 3-3. Jumper and Switch Positions (Continued)

PWA	JUMPER/ SWITCH	POSITION	FUNCTION
13 Color Framer PAL/SECAM Assy 1400133 (Continued)	J4		SECAM/PAL select
		A–B	SECAM
		A–C	PAL
	S1	On	Normal. Enable color framer in all playback modes.
		Edit	Enables color framer only during assemble and insert edit modes.
		Off	Disables color framer in all playback modes.
	S2	Normal	Normal. Selects playback phase.
		Invert	Reverses normal playback phase.
13 Color Framer PAL-M Assy 1400136	J1		Remote color framer
		A–B	Normal
		A–C	Disable
	J3		7.8-kHz phase select
		A–B	Normal
		A–C	Inverted
	S1	On	Normal. Enable color framer in all playback modes.
		Edit	Enables color framer only during assemble and insert edit modes.
		Off	Disables color framer in all playback modes.
	S2	Normal	Normal. Selects playback phase.
		Invert	Reverses normal playback phase.
14 Control Track Assy 1400140	J1		Control track pulse
		In	Normal
		Out	Test
	J2		One-field delay
		A–B	50 Hz
		A–C	60 Hz
	J3		Standard select
		A–B	NTSC
		A–C	PAL-M
	S2		Five-section switch module used to set up color frame operation.

Table 3-3. Jumper and Switch Positions (Continued)

PWA	JUMPER/ SWITCH	POSITION	FUNCTION
14 Control Track Assy 1400140 (Continued)	S2-1		Reference jam
		Open	Recorded position of flag (alternate frame identification pulse) will follow reference information from Color Framer PWA. Recorded control track will follow this change during recording.
		Closed	Color framer reference is recognized when recording starts but will not change as recording continues. A continuous control track will be recorded.
	S2-2		Edit flag continuous (switch used in conjunction with S1-1)
		Open	In assemble edit mode, alternate frame identification pulse (flag) will follow information. This may be the opposite phase of earlier material.
		Closed	Flag will be same phase as in earlier recording.
	S2-3		Edit standard phase—allows or denies the operator control over color framing phase
		Open	Operator can make normal or inverted edits.
		Closed	Operator has no control, and edit will always be of normal phase when in the edit mode.
	S2-4		SECAM—not used in an NTSC system. Normally left open.
		Open	Normal operation.
		Closed	Test position only.
	S2-5		4-frame select Not used in an NTSC system. Normally left closed.
		Open	Not used
		Closed	Normal operation
14 Control Track 625 Assy 1400146	S2		Five section SPST switch used to set up color frame operation.
	S2-1		Reference jam
		Open	Recorded position of flag (color frame identification pulse) will follow reference information from Color Framer PWA. Recorded control track will follow this change during recording.
		Closed	Color framer reference is recognized when recording starts but will not change as recording continues. A continuous control track will be recorded.

Table 3-3. Jumper and Switch Positions (Continued)

PWA	JUMPER/ SWITCH	POSITION	FUNCTION
14 Control Track 625 Assy 1400146 (Continued)	S2-2		Edit flag continuous (switch used in conjunction with S2-1)
		Open	In assemble edit mode, alternate frame identification pulse (flag) will follow information. This may be the opposite phase of earlier material.
		Closed	Flag will be same phase as in earlier recording.
	J1		Control track pulse
		A–B	Normal operation.
		B–C	Test position.
	J2		PAL/SECAM select jumper
		A–B	PAL
		A–C	SECAM
15 Capstan Servo Assy 1400153	J1		Capstan MDA drive
		In	Normal
		Out	Test
	J2		Editor interface
		B–C	Normal
		A–B	Editor interface position
	S1	TSO fast	15% increase in tape speed.
		Normal	Normal. Standard tape speed.
		TSO slow	15% decrease in tape speed.
16 Time Code Reader/Gen Assy 1400160	J1		Color phase inhibit
		B–C	Normal
		A–B	Inhibit
	J2		LOC/REM select
		A–B	Normal LOC
		B–C	Remote enabled position
	S1	Center	Normal
		Adv. (right)	
		Shift (left)	
	S2	Center	Normal
		Load (right)	
		OF/FF (left)	
	S3	1	Normal tape timer
		2	Time code reader
		3	TCG 1
		4	TCG 1 and 2
		5	EXT. TCG
		6	EXT. time code

Table 3-3. Jumper and Switch Positions (Continued)

PWA	JUMPER/ SWITCH	POSITION	FUNCTION
16 Time Code Reader/Gen Assy 1400160 (Continued)	S4	1	Normal cont.
		2	Continuous
		3	Hold
		4	Sequence
		5	Slave
		6	Test
	S5	Time (left)	Normal time code
		User (right)	User bits
17 Control Assy 1400176	J1		60/50 Hz select bus
		In	60 Hz
		Out	50 Hz, and enables J2
	J2		Sync/audio channel 4 disable (J2 operates only if J1 is in 50-Hz position)
		A–C	Audio channel 4 disable, sync enable
		B–C	Sync disable, audio channel 4 enable
		Out	Normal
	J3		Audio mute
		A–B	Mutes audio in shuttle mode
		A–C	Mutes audio when tape exceeds 2 X play speed
		A–D	No muting
	S4		Two-section switch module used to determine shuttle operating procedures.
	S4-1	Open	Normal shuttle (with S4-2 open). Shuttle knob is rotated to select direction and speed, but SHTL mode will not be activated until SHTL button is pressed. If shuttle knob is in any position other than detent when SHTL button is pressed, transport will assume the direction and speed indicated by that position.
	S4-1	Closed	Auto shuttle (with S4-2 open) — If shuttle knob is in detent, it may be rotated to select direction and speed. This will activate shuttle mode without the need to press the SHTL button. If shuttle knob is not in detent it must be rotated through detent to activate shuttle mode, then rotated to select direction and speed. Also, SHTL button may be pressed to active shuttle mode as described for S4-1 open position.

Table 3-3. Jumper and Switch Positions (Continued)

PWA	JUMPER/ SWITCH	POSITION	FUNCTION
17 Control Assy 1400173 (Continued)	S4-1 (Con't)		**NOTE** **Shuttle mode may not be initiated by use of the shuttle knob when in slow, play, or record mode, only when in normal play or stop modes.**
	S4-2		Shuttle detent select
		Open	Shuttle operation is as described for S4-1.
		Closed	Shuttle operation is as described for S4-1, except shuttle knob must always be turned through detent before tape movement occurs.
18 Search Assy 1400183	J1		Auto stop
		In	Normal
		Out	Auto stop inhibit
	J2		EOT slow down/stop
		A–B	(Normal) rewind speed auto slowdown is enabled.
		A–C	Rewind auto stop is enabled
	J3		Shut down inhibit
		In	Normal
		Out	Shutdown inhibit
	J4		Tape speed
		Out	Normal
		In	Slow (test)
	J5		Tension response
		In	Normal
		Out	Test
	S1	On (up)	Cues to preroll point 5 seconds (NTSC/PAL-M) or 7 seconds (PAL/SECAM) ahead of entrance mark.
		Off (center)	Cue to entrance mark.
		On (down)	Cues to preroll point 33 frames ahead of entrance mark.
	S2	Left	Normal. Metal reel tension.
		Right	Spot reel tension.
19 Tape Timer Assy 1400190	S1	Full frame	Normal. Normal is forced in PAL/SECAM.
		Drop frame	Allows use of tape timer as a reel time readout.
Line Driver (Audio) Assy 1400202	J4		Audio meter muting
		A–B	Postmute
		B–C	Premute
	J5		Audio monitor muting
		A–B	Postmute
		B–C	Premute

3-4. POWER FUSES

There are four fuses in the VPR. Two fuses are located on the power regulator heat sink and two fuses are located on the AST Driver PWA, as shown in Figure 3-1. To gain access to the fuses on the heat sink, remove the two right-hand screws that secure the Power Regulator PWA to the heat sink bracket and pivot the PWA to the left side, as shown in Figure 3-1. Table 3-4 is a list of the VPR fuses.

3-5. INDICATOR LAMPS

The same type of incandescent lamp is used for illumination of the four meters and for the six pushbutton indicators. The lamp used is rated at 14 volts but is operated at 11 volts to prolong lamp life. The lamp used is General Electric No. 382, 14V, 80 mA (Ampex Part No. 060-407).

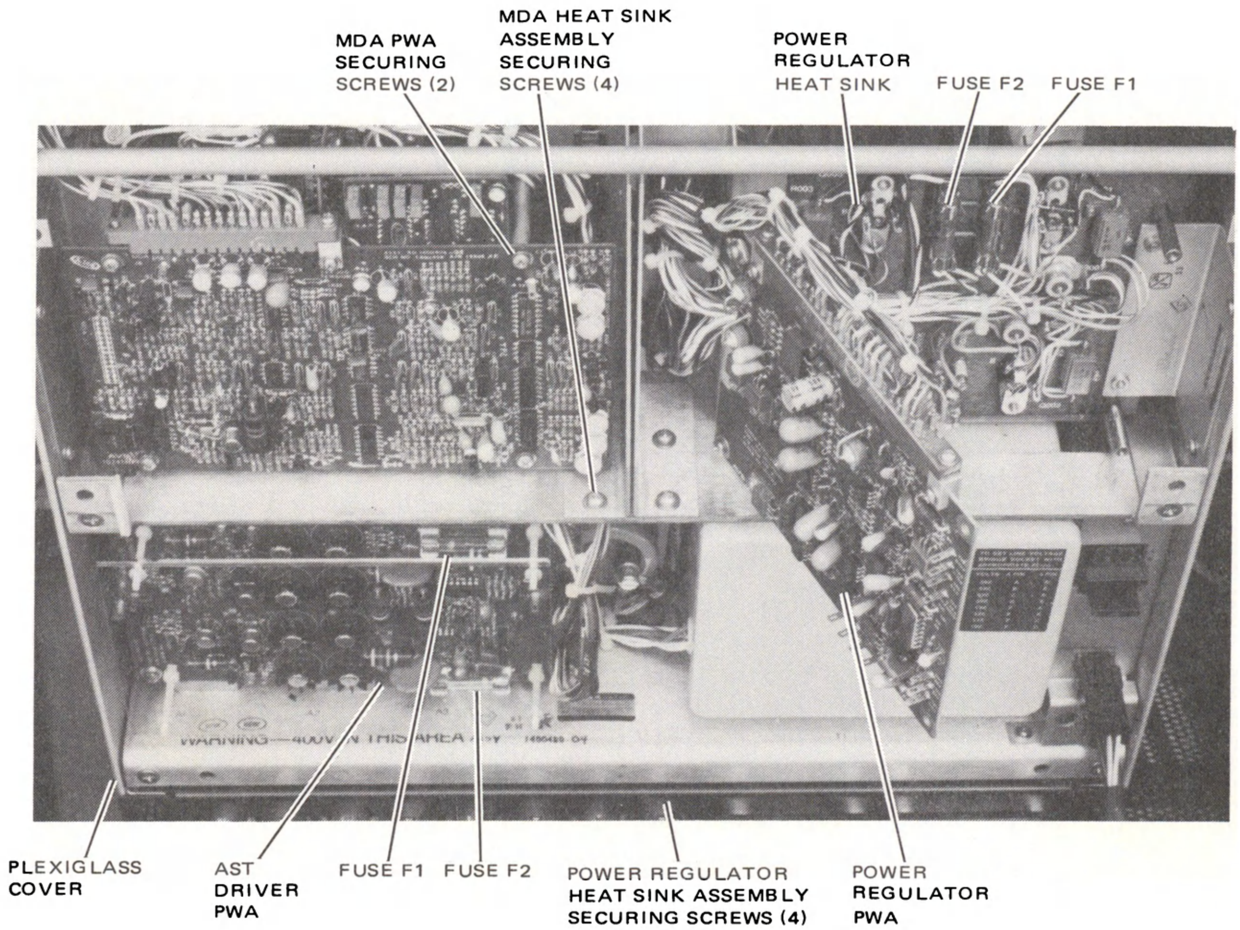


Figure 3-1. VPR-2B Fuse Locations and Various Securing Screws

Table 3-4. VPR-2B Fuses

CIRCUIT	TYPE	AMPEX PART NO.	LOCATION
+200V supply (F1)	1/32A, 250V, FB	070-409	AST Driver PWA
-200V supply (F2)	1/32A, 250V, FB	070-409	AST Driver PWA
5.0V regulator and 110V lamp supply (F1)	15A, 32V, SB	070-431	Power regulator heat sink
+48V brake, capstan, and pinch roller solenoids (F2)	1.5A, 250V, FB	070-012	Power regulator heat sink

3-6. Meter Lamp Replacement

The meter lamps are mounted in lamp sockets located on the Audio Level PWA chassis. To replace a meter lamp, proceed as follows:

1. To gain access to the Audio Level PWA chassis, remove the two screws from the top control panel (one screw on each side of the panel) and pivot the control panel forward.
2. To gain access to the lamp sockets, remove the two crosshead screws that secure the Audio Level PWA to the chassis.
3. Replace the defective lamp(s) and reinstall the Audio Level PWA and the control panel in the reverse order of removal.

3-7. Pushbutton Switch Indicator Lamp Replacement

To replace a pushbutton switch indicator lamp, proceed as follows:

1. From the front of the control panel, remove the pushbutton from the switch by pulling the pushbutton straight out from the switch.
2. Pull the defective lamp out from the rear of the pushbutton and install a new lamp.
3. Reinstall pushbutton by pressing pushbutton into switch receptacle until pushbutton locks in place.

3-8. TRANSPORT TRIM AND SCANNER SHROUD REMOVAL PROCEDURE

Most transport maintenance and adjustment operations require removal of covering trim panels to provide access to components mounted on the top surface of the transport base casting. Items to be removed, as required for maintenance or adjustment procedures, are identified in Figure 3-2.

1. Remove tape and reels from the transport.
2. Open the upper and lower clamshell covers shown in Figure 3-2.
3. Remove the audio shield and cover assembly by carefully pulling it straight up from the transport.
4. Remove the screw that secures the supply idler cover, and remove the cover. (Note: when this cover is to be installed, note that a recess in the bottom portion of the cover fits over the screw head that mounts the upper guide on the supply side—longitudinal head base.)
5. Remove the two screws from the right side of the timer idler assembly cover and remove the cover. (Note: when this cover is to be reinstalled, note that a recess in the upper portion of the cover is to be placed over the screw head on the top of the counter.)

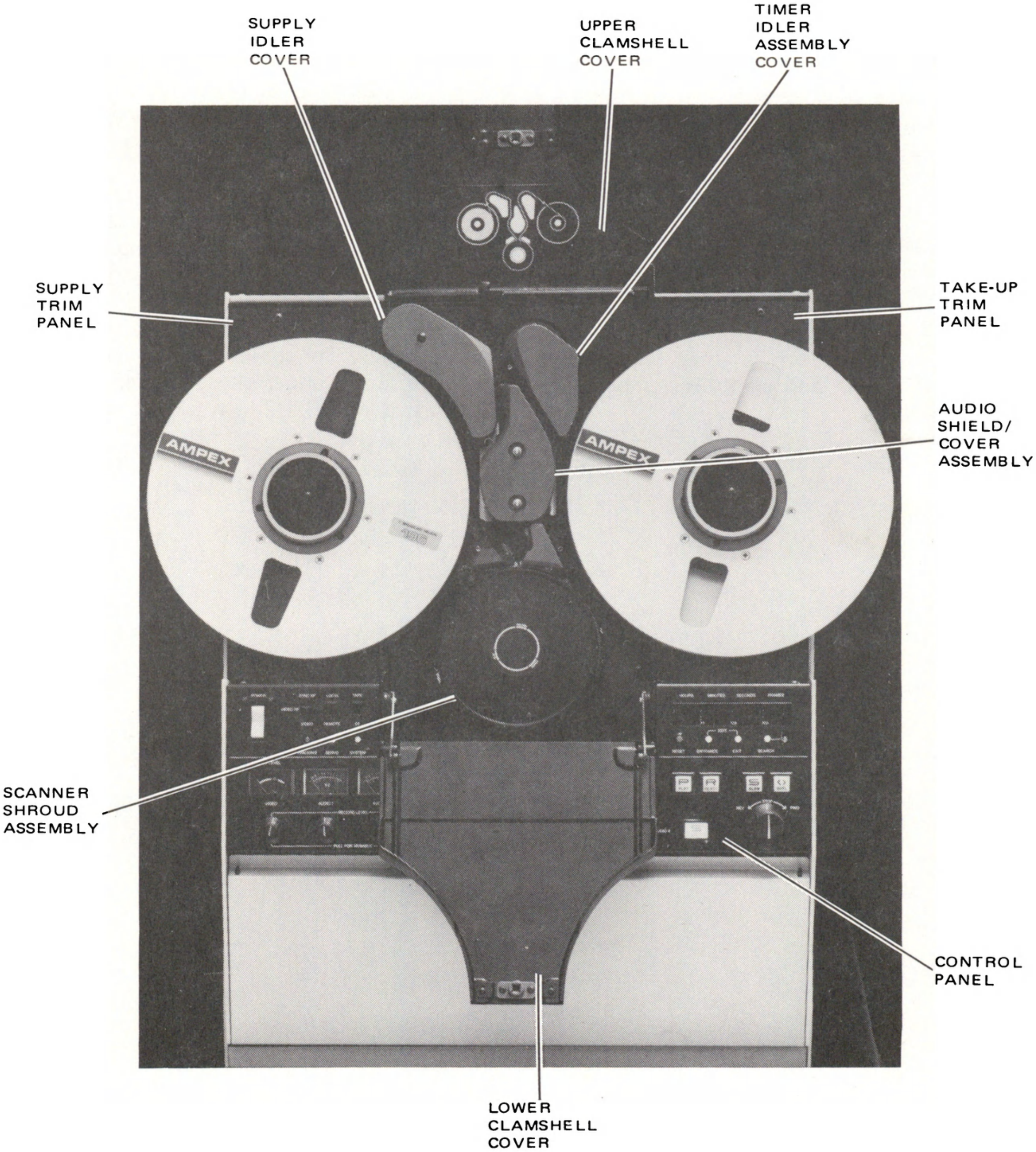


Figure 3-2. VPR-2B Trim Parts

6. Remove the two screws from the top of the control panel (one screw on each side of the panel) and pivot the control panel forward.

CAUTION

WHILE PERFORMING STEPS 7 AND 8, BE CAREFUL NOT TO SCRATCH THE LONGITUDINAL HEADS ON ADJACENT TRIM PARTS.

7. Remove the three screws that secure the takeup trim panel, and carefully remove the panel.

8. Remove the three screws that secure the supply trim panel and carefully remove the panel.

CAUTION

ALWAYS POSITION SCANNER PLAY HEAD TO 12 O'CLOCK POSITION BEFORE REMOVING SHROUD. WHEN REMOVING THE SCANNER SHROUD ASSEMBLY, WHICH CONSISTS OF THE SCANNER SHROUD AND LOWER COVER, USE EXTREME CARE NOT TO RUB THE SCANNER SURFACE OR HIT THE VIDEO HEAD TIPS.

9. To remove the scanner shroud assembly, remove the four screws that secure the shroud assembly to the base casting and carefully remove the shroud and lower cover.

10. Reinstall transport trim and scanner shroud assembly in the reverse order of removal. Position scanner shroud carefully so it will not touch 10-1/2-inch takeup reel hub.

3-9. PREVENTIVE MAINTENANCE

3-10. Maintenance Schedule

It is important that preventive maintenance, consisting of cleaning, demagnetizing, and scheduled component replacement procedures be performed at the intervals recommended. Table 3-5 provides a list of the preventive maintenance procedures and the intervals at which they should be performed.

3-11. Cleaning

3-12. Head and Tape Path Cleaning. Oxide particles from the magnetic tape tend to collect on components in the tape path. These oxide accumulations degrade the performance of the recorder. The heads and all other components in the tape path must be cleaned after each 8 hours of operation or more frequently, depending on the operational environment and the type and cleanness of the tape used. Visual inspection of the scanner, guide and capstan surfaces should be made prior to every major record/playback session. If oxide residue is present on any of these surfaces, the oxide should be removed utilizing the recommended cleaning agent.

CAUTION

IT IS VERY IMPORTANT TO RESTRICT THE USE OF THE CLEANING AGENTS ONLY TO THE PARTS WHICH ARE INTENDED TO BE CLEANED AND TO AVOID USING EXCESS AMOUNTS. THESE AGENTS MAY AFFECT THE SURFACE FINISH OF OTHER PARTS SUCH AS PLASTICS OR ATTACK CERTAIN BONDING AGENTS.

3-13. Video Heads and Scanner. Clean the heads and scanner as follows:

CAUTION

DO NOT CLEAN THE HEADS USING A VERTICAL MOTION AGAINST THE HEAD AS DAMAGE TO THE HEAD CAN OCCUR. ALSO, DO NOT USE ALCOHOL TO CLEAN THE SCANNER SURFACE AS IT TENDS TO LEAVE A PERSISTENT RESIDUE THAT CAN INCREASE FRICTION BETWEEN THE TAPE AND SCANNER.

1. Moisten a cotton swab with Ampex Head Cleaner (Ampex Part No. 087-007), or xylene. Hold the swab steady in the vicinity of the head to be cleaned and rotate the upper

Table 3-5. Maintenance Schedule

MAINTENANCE PROCEDURE	NEW VIDEO HEAD INSTALLED	INTERVAL	PARAGRAPH REFERENCE
Heads, tape path, scanner, capstan, and pinch roller cleaning	X	8 hr	3-11 thru 3-15
Trim panels and cabinet surface cleaning	–	As required	3-16
Capstan motor brushes and rotor cleaning	–	2,000 hr	3-17
Scanner slip ring and brush assembly cleaning	–	As required – see text	3-18
Scanner motor brushes and rotor cleaning	–	1,000 hr	3-19

scanner back and forth slowly so that the head alternately contacts the swab.

2. Clean the scanner with a soft clean lint-free paper (kimwipes,[1] for example) using Ampex Head Cleaner or xylene.

3. Remove all residue from cleaned surfaces.

3-14. Tape Guides, Audio Heads, and Capstan. Clean the tape guides, audio heads, and capstan with a cotton swab moistened with Ampex Head Cleaner or xylene. Remove all residue from the cleaned surface.

3-15. Pinch Roller. Proceed as follows:

CAUTION

DO NOT USE HEAD CLEANER ON THE RUBBER CAPSTAN PINCH ROLLER. TO DO SO CAN DETERIORATE THE RUBBER SURFACE.

(1) Trademark—Kimberly-Clark Corporation

Clean the surface of the pinch roller with a soft, clean, lint-free paper or cloth towel moistened with 92% isopropyl alcohol.

3-16. Trim Panels and Cabinet Surfaces. Trim panels and cabinet surfaces should be kept clean. Clean the painted trim panels and console cabinet surfaces with a mild soap solution. Remove all residue with clear water and allow to dry.

3-17. Capstan Motor Brushes and Rotor. The capstan motor brushes and rotor should be cleaned after each 2,000 hours of operation. The brushes and rotor may be cleaned without removing the entire motor. Proceed as follows:

1. To gain access to the capstan motor, remove the back panel of the cabinet and the fan assembly (six crosshead screws). Disconnect fan connector.

2. Disconnect capstan motor power connector shown in Figure 3-3.

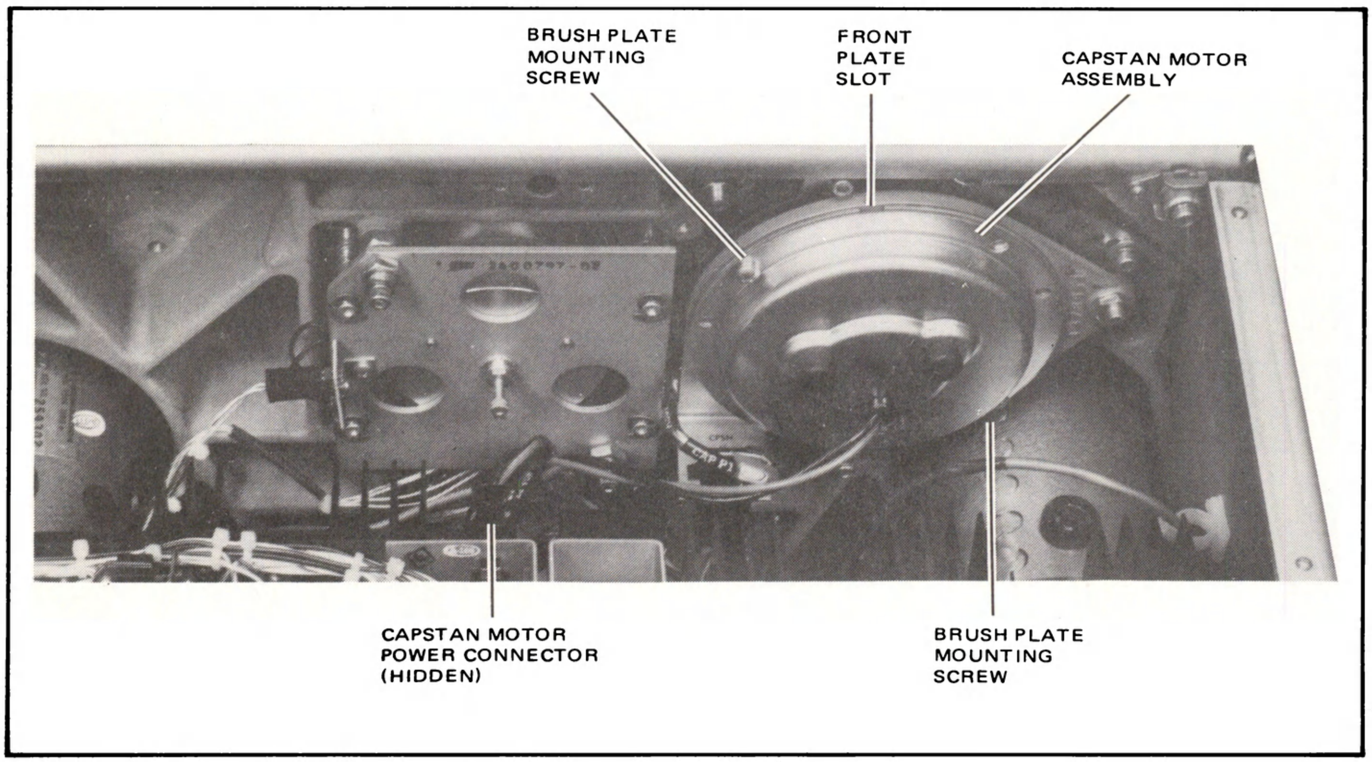


Figure 3-3. Capstan Motor Assembly

3. Remove the two 8-32 crosshead screws that secure the motor brush plate to the capstan motor housing.

CAUTION

WHILE PERFORMING THE NEXT STEP, USE CARE TO PULL THE MOTOR BRUSH PLATE STRAIGHT OUT OF THE MOTOR HOUSING WITHOUT SLIDING IT LATERALLY, AS DAMAGE TO THE ROTOR CAN OCCUR. DO NOT SCRATCH OR TOUCH PRINTED MOTOR ROTOR SURFACE, ESPECIALLY IN COMMUTATOR AREA. IN ADDITION, A CLEAN CLOTH OR PAPER TOWEL SHOULD BE PLACED UNDER THE MOTOR AS THE BRUSH PLATE IS REMOVED SO AS TO PREVENT THE ACCUMULATED BRUSH PARTICLES FROM FALLING ONTO THE ELECTRONICS.

4. The permanent magnet within the motor brush plate tends to hold the plate to the motor housing. Use a flat-bladed screwdriver in the slot provided in the front plate of the motor to carefully pry the plate up from the housing and remove the motor brush plate.

CAUTION

TAKE CARE TO PREVENT METALLIC PARTICLES FROM GATHERING ON THE PERMANENT MAGNET.

5. Clean all contamination from the brushes, permanent magnet, and rotor with a soft, lint-free cloth moistened with isopropyl alcohol. Remove all residue. Allow brushes to dry.

6. Reinstall motor brush plate onto the capstan motor housing using screws removed in step 3.

7. Reconnect capstan motor power connector removed in step 2.

8. Reinstall fan and back panel assembly removed in step 1.

3-18. Scanner Slip Ring and Brush Assembly. The scanner slip rings and slip ring brushes do not require periodic cleaning. However, cleaning will be required if a once-around (60-Hz) noise pulse appears in the audio output or if a noise band appears in the video display. The slip rings and slip ring brushes are cleaned with isopropyl alcohol. To clean the slip ring and brushes, proceed as follows:

1. Remove the scanner assembly from the transport by performing steps 1 through 7 of the *Scanner Assembly Removal and Replacement* procedure, paragraph 3-158.

2. Install leg set assembly (Table 3-2) on scanner and rest inverted scanner/leg set on bench.

3. With the rear of the scanner facing upward, remove the two 6-32 screws that secure the motor cover to the drum adaptor plate and remove the cover.

4. Lightly spray alcohol onto the slip ring to cleanse silver rings. Slowly turn the scanner drum so that the brushes wipe the slip rings. Soak up excess cleaning agent using a lint-free cloth or tissue (a cotton tipped swab may be used to wipe slip rings if great care is used to ensure that a cotton filament is not left behind to foul brushes). Permit slip rings and brushes to dry thoroughly before proceeding.

5. Reinstall motor cover removed in step 3.

6. Separate leg set from scanner. Reinstall scanner onto the transport in the reverse order of removal. When installing scanner onto the base casting, be sure that scanner mounts flush to the casting and there are no interfering components or wires.

3-19. Scanner Motor Brushes and Rotor. For maximum scanner rotor life, the scanner motor brushes and rotor should be cleaned after each 1,000 hours of use. The cleaning procedure requires that the scanner be removed from the transport. Proceed as follows:

1. Remove the scanner assembly from the transport by performing steps 1 through 5 of the *Scanner Motor Brush Replacement* procedure, paragraph 3-162.

2. Clean the rotor surface with isopropyl alcohol and remove all residue. Clean the motor brushes and interior of the brush plate assembly with isopropyl alcohol. Remove all residue. Allow brushes to dry.

3. Reassemble scanner and replace it onto the transport using the *Scanner Motor Brush Replacement* procedure, paragraph 1-162, steps 10 through 12.

3-20. Demagnetizing

The heads should be demagnetized after each 8 hours of operation. Heads and other components in the tape path can acquire permanent magnetization that can degrade signal-to-noise, increase distortion, and partially erase high frequencies on recorded tapes. Use a head demagnetizer to demagnetize the heads, tape guides, and capstan. Use a hand-held bulk erase demagnetizer to demagnetize the trim plates and other general components in the tape path.

3-21. Lubrication

CAUTION

LUBRICATE NO PART OF THIS MACHINE EXCEPT WHEN:

1. **INSTRUCTED TO DO SO IN MAINTENANCE PROCEDURES, AND (WHEN SO INSTRUCTED),**

2. **USING ONLY SPECIFIED LUBRICATING MATERIAL.**

All critical wear surfaces incorporate prelubricated ball bearings, permanently lubricated sleeve bearings, impregnated lubricants, or lubricant-filled materials.

3-22. CORRECTIVE MAINTENANCE

3-23. Introduction

The corrective maintenance section of this manual is divided into four main headings as follows: Troubleshooting Aids, Mechanical Adjustments, Electrical Checks and Adjustments, and Component Replacement Procedures.

3-24. Troubleshooting Aids

CAUTION

TO PREVENT POSSIBLE DAMAGE TO ELECTRICAL COMPONENTS, ALWAYS TURN VPR POWER OFF BEFORE REMOVING OR INSTALLING A PRINTED WIRING ASSEMBLY (PWA) INTO THE VPR.

1. All adjustments are performed at the factory prior to shipment. New adjustments should only be performed when required by repair or replacement and when proper test equipment is available. Those adjustments which require special test equipment are listed at the beginning of each PWA procedure.

2. Components and test points in the text procedures are identified with electronics assembly PWA number preceding the control or test point symbol reference. For example, 3 TP4 indicates the test point is located on PWA 3.

3. Use standard troubleshooting techniques to isolate a fault as mechanical or electrical in origin, then proceed to isolate the fault to a certain state or component. Recommended tools, test equipment, and cleaning materials that may be required are listed in Tables 3-1 and 3-2.

3-25. VPR-2B Indicators. VPR-2B indicators are located on the front panel, and on PWA front edges. The SYSTEM, SERVO, TRACKING, SEARCH, and INTERVAL indicators (front panel LED's) exist to display overall system operational status. These indicators are normally out, but may light during certain shuttle, edit, or other transient operations. PWA front edge indicators (LED's) assist the operator in pin-pointing the origin of abnormal or nonstandard conditions. In this capacity, PWA indicators commonly light to accompany front panel indicators.

3-26. *Front Panel Indicators.* Table 3-6 lists factors which may cause the front panel SYSTEM, SERVO, TRACKING, SEARCH, INTERVAL, and RECORD LOCKOUT indicators to light. The associated secondary indicators (on PWA's) are listed where applicable. Figure 3-4 shows conditions which may cause the system indicator to light. Refer to Table 3-6 and to Figure 3-4 as required.

3-27. Mechanical Adjustments

3-28. Capstan Pinch Roller Pressure Adjustment. In play or record modes, when the capstan solenoid is energized, the pinch roller force against the capstan shaft should be 7.0 pounds (3.18 kg). The force is adjusted by turning a locknut that compresses a spring on the capstan solenoid (Figure 3-5). To measure and adjust capstan pinch roller pressure and, if required, adjust capstan/pinch roller clearance and solenoid plunger/stop bracket clearance, proceed as follows:

1. Remove tape and reels from the transport.

2. Remove transport trim to gain access to the capstan solenoid and pinch roller (refer to *Transport Trim and Scanner Shroud Removal Procedure*, paragraph 3-8).

3. Measure clearance between capstan shaft and rubber pinch roller. Clearance should be 0.094 ±0.010 in. (2.38 ±0.79 mm).

4. If pinch roller clearance is not correct, loosen the two 6-32 socket-head screws that secure the stop bracket (Figure 3-5) to the solenoid and adjust position of stop bracket to the middle of its range and tighten screws.

5. Loosen the three cross-recessed screws that secure the solenoid to the transport casting, and adjust solenoid position to obtain clearance of 0.094 ±0.030 in. (2.38 ±0.79 mm).

Table 3-6. Control Panel Indicators

FRONT PANEL INDICATOR(2)	SECONDARY INDICATOR(1,2) NAME	SECONDARY INDICATOR(1,2) LOCATION	FUNCTION/CAUSE
System (yellow LED)			Indicates the following abnormal operation or potential malfunction conditions:
	HI LINE (red LED)	Search PWA 18	Indicates line voltage is at least 10% greater than LINE VOLTAGE SELECT connector setting.
	LO LINE (red LED)	Search PWA 18	Indicates line voltage is at least 10% less than LINE VOLTAGE SELECT connector setting.
	SPOT	Search PWA 18	REEL TYPE indicator: works in conjunction with REEL TYPE switch. Denotes reel type switch is in the spot reel position—servo operation not compatible with metal reels.
	TACH SELECT (amber LED)	Scanner Servo PWA 11	Denotes the AUTO/TACH switch (Scanner Servo PWA) is in TACH position. This mode results in less resolution and accuracy in servo operation.
	SYNC SEL NON-STD (amber LED)	Reference PWA 12	Only lights when a sync is needed but is not available. Thus, it lights when: 1. There is no video in, and VPR is in edit mode (even if a reference signal is present). 2. Both the video and reference signals are missing.
	AST NON-STD (amber LED)	AST Servo PWA 9	Reveals nonstandard conditions: 1. AST servo edge mounted ON/OFF switch is in OFF position. 2. AST servo jumper J1 is either in SAW or SINE position.
	SYNC P/B OFF (amber LED)	Playback Sync Processor PWA 8	Denotes Playback Sync Processor PWA edge mounted sync head P/B ON/OFF switch is in OFF position—(J1 configured A-to-B).
SERVO (red LED)	SERVO UNLOCKED (red LED)	Capstan Servo PWA 15	Does not light when machine is in variable, slow, or TSO mode. May light in normal play or record mode. Normally lit prior to run up—extinguishes when READY is pressed (after delay). When lit, indicates that the capstan servo is unlocked. This action may be caused by:

Table 3-6. Control Panel Indicators (Continued)

FRONT PANEL INDICATOR(2)	SECONDARY INDICATOR(1,2)		FUNCTION/CAUSE
	NAME	LOCATION	
SERVO (red LED) (Continued)	SERVO UNLOCKED (red LED) (Continued)	Capstan Servo PWA 15 (Continued)	1. Tape speed not correct (in play or record). 2. Control track is not present (in play or record). 3. Capstan servo not locked—indicated by CT LOCK signal from Control Track PWA pin 54 (input to Capstan Servo PWA at pin 53) being not true.
	SERVO UNLOCKED (red LED)	Scanner Servo PWA 11	Normally does not light when machine is in ready, play, or record mode. When lit, indicates that scanner servo is unlocked. This action may be caused by: 1. Floating tach system is shiftinq. 2. Scanner tach error exceeds 16 μs. 3. Scanner speed is slow or fast.
TRACKING (amber LED)	None		Operates in conjunction with VAR TRACKING potentiometer and UNITY TRACKING/VARIABLE switch (edge mounted on Control Track PWA) to indicate the status of capstan servo tracking as follows: 1. Not lit—tracking is within 0.5 ms of unity (either UNITY or VARIABLE tracking selected). 2. Lit continuously—tracking is off unity by the amount 0.5 to 2.5 ms. 3. Blinking—VAR TRACKING potentiometer is set to VARIABLE position by more than 2.5 ms.
SEARCH	None		Identifies the following search actions when lit: 1. Blinking—indicates that VPR is in the search mode. 2. Lit continuously—indicates that VPR is parked at the preroll point.
INTERVAL (amber LED)	None		This indicator reveals the following: 1. Blinks to show that the entrance and exit points are reversed (in non-ASSEMBLE edit mode). 2. Blinks when the ASSEMBLE edit mode is selected to warn the operator that once recording is initiated, it will continue until manually terminated. 3. Lights continuously if the tape position is within the edit interval.

Table 3-6. Control Panel Indicators (Continued)

FRONT PANEL INDICATOR(2)	SECONDARY INDICATOR(1,2)		FUNCTION/CAUSE
	NAME	LOCATION	
INTERVAL (amber LED)	None		**NOTE** **The INTERVAL indicator and PLAY button indicator interact such that the PLAY button lights during play portions of edit operations, giving visual indication of VPR PLAY/RECORD sequence.**
RECORD LOCKOUT	None		Lights continuously to indicate activation of RECORD LOCKOUT switch on Control PWA or when all AUDIO/VIDEO record select switches are off. Blinks when one or more AUDIO or VIDEO record select switches are in the OFF position.
A3/A4 VU Meter	None		Indicates when Audio 4 is displayed on vu meter.

(1) Secondary indicators are located on PWA front edges.
(2) Denotes the indicated condition, only when lit.

6. Place a Q-tip (or other opaque light barrier) between halves of the end-of-tape sensor, as noted in Figure 3-6, to defeat the sensor. This enables the capstan to rotate and solenoid to be energized in play mode without tape threaded on the transport.

7. To prevent unnecessary wear and a flat spot on the parking brake tire while making the pinch roller adjustments, place a rubber band on the supply brake solenoid assembly and on the takeup brake solenoid assembly to simulate an energized solenoid condition. Place a rubber band around the brake solenoid housing and the pivot shaft, as shown for the takeup solenoid in Figure 3-7.

8. Apply VPR power and press PLAY pushbutton to energize solenoid.

9. Measure clearance between end of solenoid plunger and stop bracket. Clearance should be 0.125 ±0.30 in. (3.175 ±0.79 mm).

10. If plunger and stop bracket clearance is not correct loosen the two 6-32 socket-head screws that secure the stop bracket (Figure 3-5) to the solenoid, and adjust position of stop bracket to obtain clearance specified in step 9. Repeat steps 5, 9, and 10 until both clearance requirements are met.

CAUTION

WHILE PERFORMING THE FOLLOWING STEP, PERMIT NO PART OR PIECE TO FALL INTO THE SCANNER AREA OR VPR ELECTRONICS.

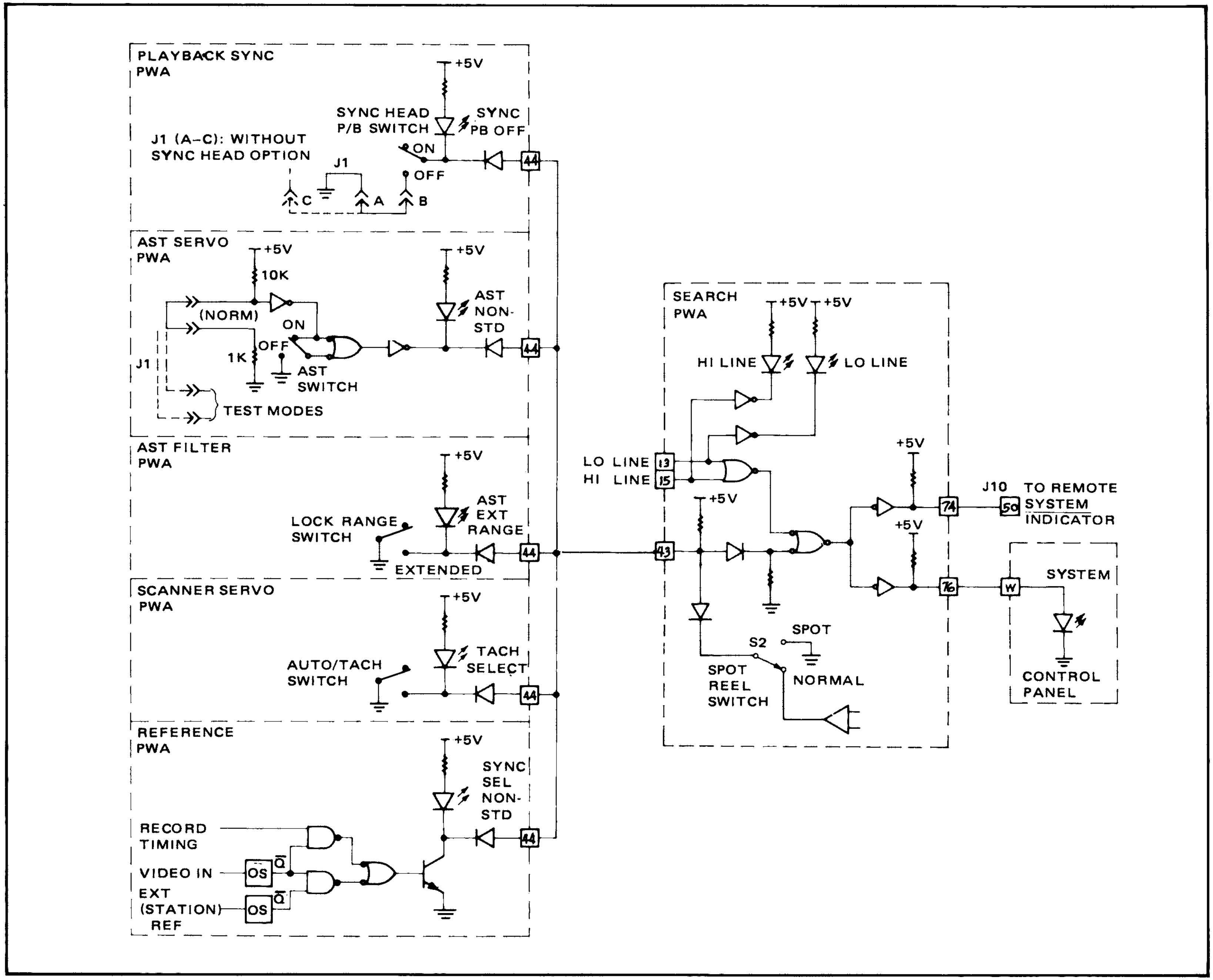


Figure 3-4. Conditions Activating the System Indicator

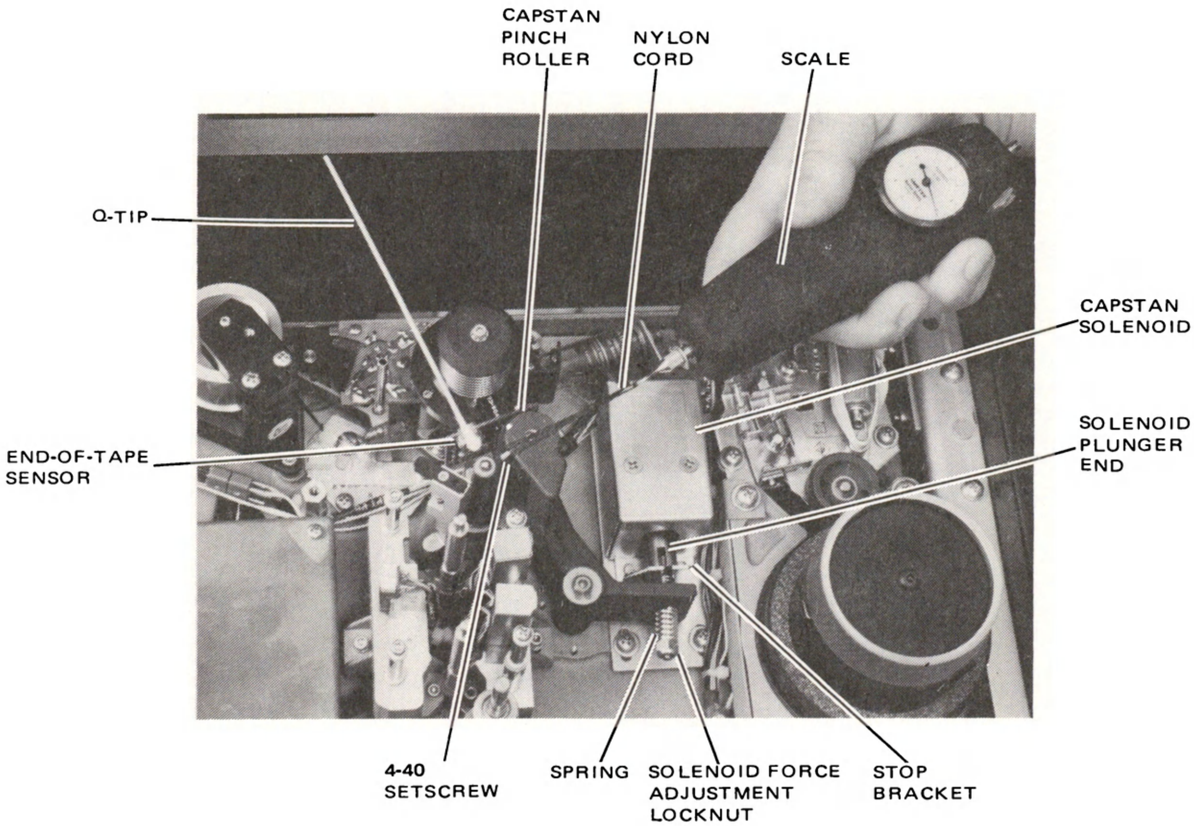


Figure 3-5. Capstan Pinch Roller Pressure Adjustment

11. Carefully remove the thrust wand (with stiffener and spacer if present) by removing the cross-recessed screw. Drop no part in the process. The thrust wand contacts the ball bearing atop the capstan shaft.

12. Install a 4-40 X 1/4-inch long set-screw into the threaded hole located on the capstan pinch roller arm, as shown in Figure 3-6.

13. Connect a knotted loop of lacing, nylon cord or thin twine to the screw installed in step 12 and insert hook of a 10-pound (4.5-kg) scale onto the loop. Pull loop with spring scale in direction shown in Figure 3-5.

14. Press PLAY pushbutton to energize solenoid.

15. Observe on scale the amount of force required to eliminate pinch roller to capstan contact. The pinch roller will stop rotating when it breaks contact with the capstan. The force required should be 7.0 ±0.25 pounds (3.18 ±0.1 kg).

16. If force needs to be adjusted, turn capstan solenoid force adjustment locknut (Figure 3-5) in small increments clockwise to increase force. If sufficient force is not attainable, it probably means that the solenoid is not seating fully because the locknut is too tight. Loosen the locknut until the spring is slack and start adjustment over.

17. Press STOP, then PLAY pushbuttons and repeat steps 15 and 16 as required.

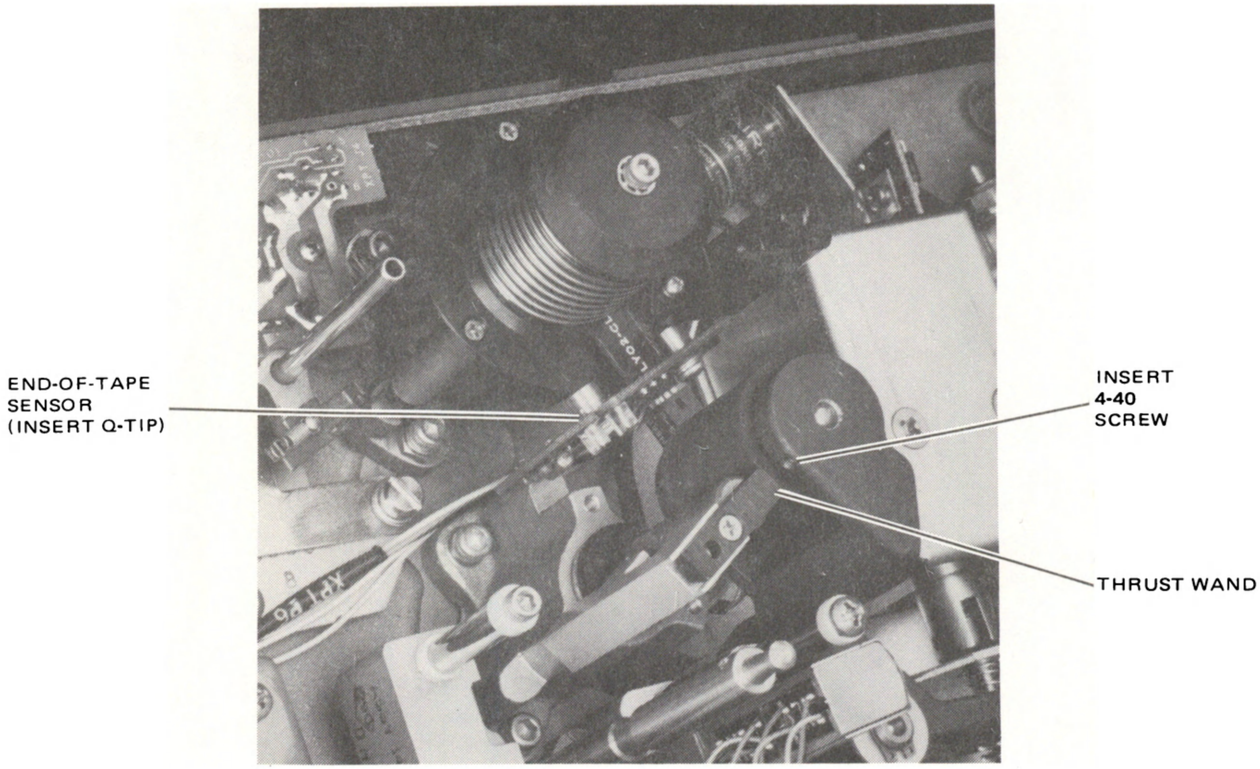


Figure 3-6. Capstan Thrust Wand

18. Press STOP pushbutton to deenergize solenoid.

19. Remove screw installed in step 12.

20. Remove Q-tip installed in step 6 and rubber bands installed in step 7.

21. Reinstall thrust wand (with stiffener/spacer, if applicable) to correct position over capstan shaft, and reinstall trim panels.

3-29. Tape Tension. The holdback and takeup tape tension is measured using a Tentelometer tape tension gauge (Table 3-1). All measurements are made using a full supply reel and minimum tape wound on the takeup reel.

NOTE

The Capstan pinch roller pressure (paragraph 3-28) should be correct before performing the tape tension adjustments.

3-30. *Tape Tension Measurement.* Proceed as follows:

1. Remove the audio head cover.

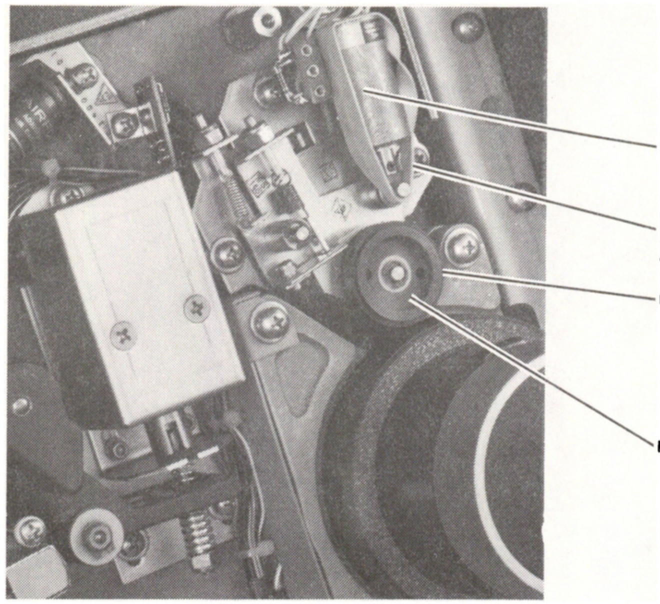


Figure 3-7. Takeup Parking Brake Solenoid

2. Thread tape onto the transport and place system into record mode.

3. Measure supply holdback tape tension with the Tentelometer placed between the scanner entrance guide and the longitudinal head assembly fixed guide, as shown in Figure 3-8. Tension should be between 4.0 and 4.5 ounces (113 to 127 grams).

4. Measure takeup tape tension with the Tentelometer placed between the timer idler wheel and the takeup reel. Tension should be 15 ± 0.5 ounces (425 ± 14 grams).

5. Reinstall audio head cover.

6. If the tape tension is out of tolerance, perform the *Tape Tension Adjustment Procedure* which follows.

3-31. *Tape Tension Adjustment Procedure.* The tape tension adjustment screw shown in

Figure 3-8. Measuring Supply Holdback Tape Tension

Figure 3-9 can be observed through a slot in the transport trim. The MDA reverse mode adjustments may be found in paragraph 5-55. Proceed as follows:

1. Remove the audio head cover.
2. Remove the one screw that secures the supply idler cover and remove the cover.
3. Clean the tape path as described in the *Preventive Maintenance* procedures.
4. Adjust holdback tape tension as follows (to adjust takeup tension, proceed to step 5):

   a. With tape threaded on transport, place system into record mode and adjust R108 (balance control) on the motor drive amplifier (MDA) so that the tension arm is in the center of its range (approximately directly over the tape tension adjust screw).

   b. Measure supply holdback tape tension in record mode as described in paragraph 3-30, step 3.

   c. Enter stop mode and slightly loosen the slotted screw. If tension is to be increased, push serrated plate upward. If tension is to be decreased, push plate downward. Tighten slotted screw.

   d. Place system into record mode and again measure holdback tape tension.

   e. Repeat steps 4c and 4d as necessary to achieve correct tension of 4.0 to 4.5 ounces (113 to 127 grams).

   f. Repeat step 4a.

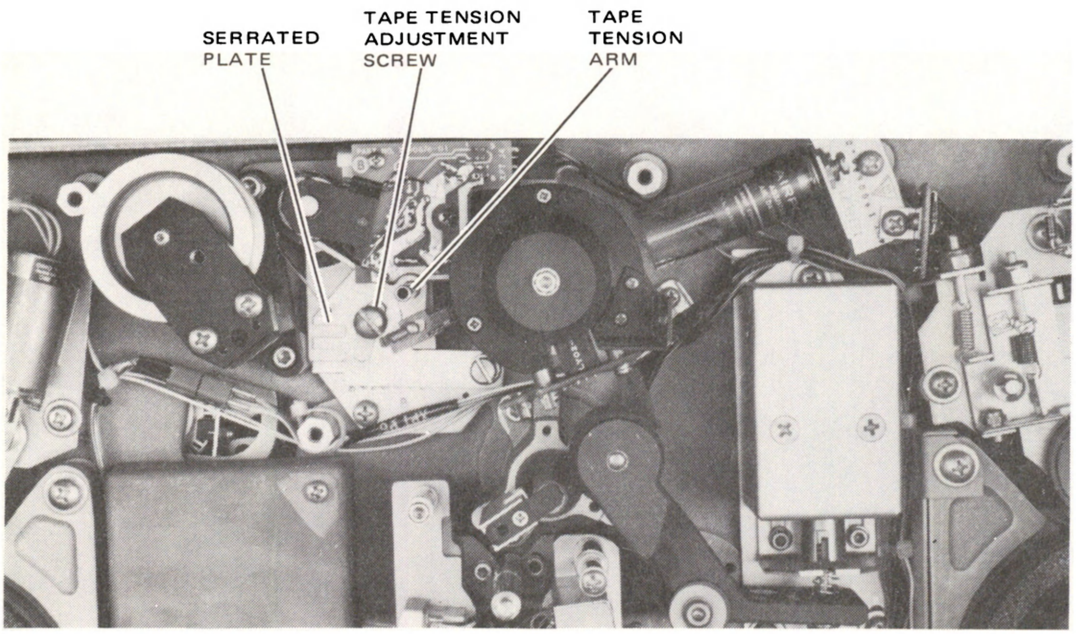


Figure 3-9. Supply Holdback Tape Tension Adjustment Screw

5. Adjust takeup tension as follows:

   a. With a maximum of 1/4-inch tape pack on the takeup reel, place system into play mode.

   b. Measure takeup tension with the Tentelometer placed between the timer idler reel and takeup reel.

   c. Adjust R145 (play takeup tension adjust) on the MDA for a takeup tension reading of 14 ±0.5 ounces (397 ±14 grams).

6. Adjust still frame takeup tension as follows:

   a. Place system into still frame mode. Press STOP then READY (TAPE/EE switch to TAPE position).

   b. Measure takeup tension with the Tentelometer placed between the timer idler wheel and the takeup reel.

   c. Adjust R134 (still takeup tension adjust) on the MDA for a takeup tension reading of 4.5 ±0.5 ounces (127 ±14 grams).

   d. Switch TAPE/EE switch to EE and back to TAPE. Then turn takeup reel by hand forward and then backward. The amount of torque necessary should feel approximately the same in either direction. If necessary, readjust R134 slightly to obtain equal torque.

   e. Recheck still frame takeup tension by repeating step 6b. Tension should not exceed 6.0 ounces (170 grams).

7. Reinstall the supply idler cover removed in step 2.

8. Reinstall audio head cover removed in step 1.

3-32. Parking Brake Adjustment Procedure. In ready, play, or record modes, when the parking brake solenoid is energized, the clearance between the supply and takeup reel turntables and the parking brake tire should be between 0.010 and 0.020 inches. The force required to load the helical return spring at the limit of travel by the solenoid armature should be 21 ± 1 ounces (594 ± 28 grams). These measurements and adjustments are made as follows:

1. Remove tape and reels from the transport.

2. Remove transport trim to gain access to the supply reel parking brake assembly.

3. Place Q-tip or other suitable opaque material in the end-of-tape sensor located between the tach timer idler and the capstan.

4. Turn the recorder power on, and depress the PLAY switch.

5. Manually stop the supply reel hub from rotating and check the clearance between the brake tire and the supply reel turntable. Refer to Figure 3-10. A feeler or other suitable thickness gauge should be used. The clearance should be between 0.010 and 0.020 inches.

NOTE

If the clearance is within the above limits, depress the STOP switch. Skip steps 6, 7, and 8 below and proceed directly to 9.

6. Slightly loosen the three mounting screws that secure the parking brake assembly to the transport. Refer to Figure 3-11.

7. Slide the parking brake assembly toward or away from the turntable as required.

8. When the correct clearance is established, tighten the three mounting screws securely. Depress the STOP switch.

9. Using a suitable gauge, measure the force required to load the helical return spring when the solenoid armature is at the limit of its travel. Measure along the centerline of the armature as shown in Figure 3-12. The required force should be 21 ±1 ounces (594 ±28 grams).

10. Adjust the nut shown in Figure 3-11 as required to achieve the correct spring tension.

11. Repeat steps 1 through 10 for the takeup reel parking brake assembly.

3-33. Reverse Tension Spring. When the recorder is switched from forward slow motion to reverse slow motion, the tension arm assembly moves suddenly to the left. The reverse tension spring prevents the tension arm assembly from striking the casting of the turnaround idler assembly. Loading the reverse tension spring absorbs the momentum of the moving tension arm assembly. Adjust the reverse tension spring as follows:

NOTE

The following procedure assumes that tension arm balance adjustment outlines under *Electrical Adjustments, Motor Drive Amplifier* has been performed.

1. Load tape on recorder and shuttle forward until tape is equally distributed between supply and takeup reels. Depress STOP switch.

2. Rotate the SHUTTLE knob fully clockwise (forward) and depress the SLOW switch. The tip of the reverse tension spring should be 0.250 ±0.06 inches from the tension arm assembly. Refer to Figure 3-13.

3. Rotate the SHUTTLE knob counterclockwise to the STOP detent. The reverse tension spring should gently stop the travel of the tension

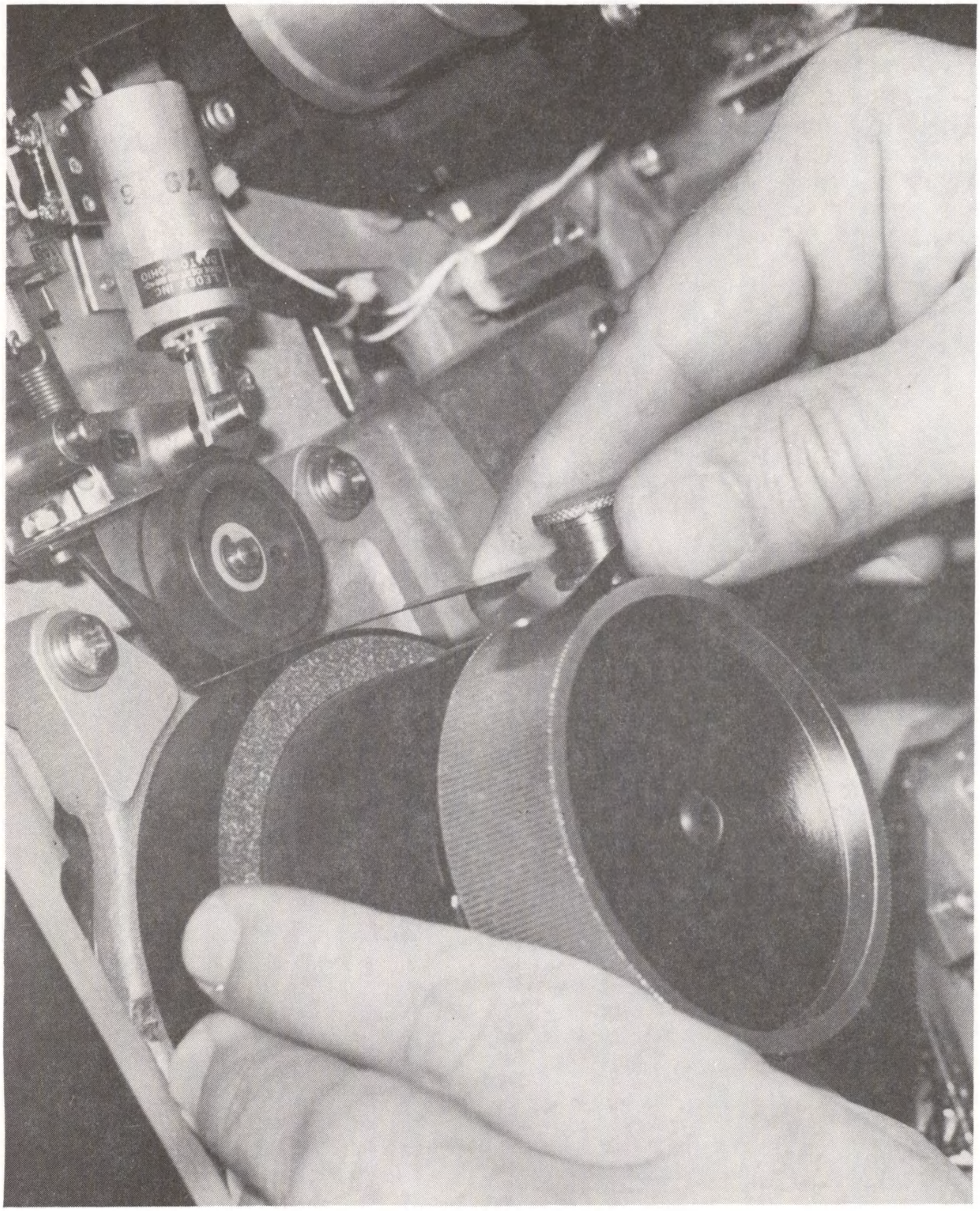


Figure 3-10. Check Clearance Between Supply Reel Turntable and Parking Brake Tire

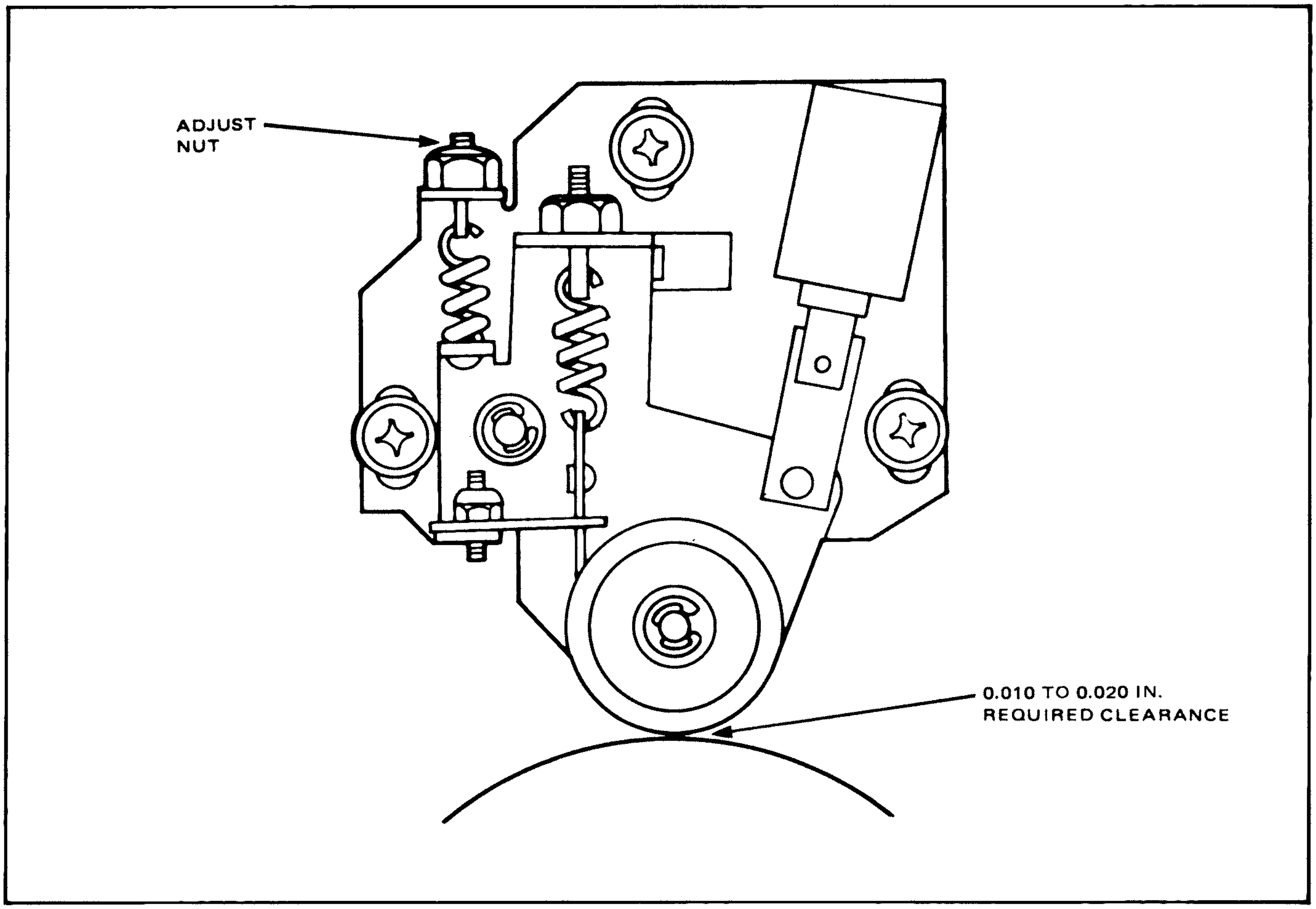


Figure 3-11. Parking Brake Assembly

arm assembly and not be in contact with it after tape motion has stopped.

4. Rotate the SHUTTLE knob counterclockwise to REV. The reverse tension spring should prevent the tension arm assembly from striking the turnaround idler casting when reverse tape motion starts. The reverse tension spring should barely touch the tension arm assembly during reverse slow-motion tape travel.

NOTE

If reverse tension spring does not perform as specified in steps 2, 3, and 4, remove the turnaround idler assembly. Detach the reverse tension spring from the turnaround idler assembly and manually reshape the spring as required.

3-34. Scanner Tach Alignment. The position of the scanner tach determines the height of video track recordings. This position has been set at the factory and should not require adjustment. However, if the scanner assembly has been disassembled or if the VTR is making recordings with errors in dropout position, then the tach position should be verified before making further adjustments. Proceed as follows:

1. Remove transport trim and scanner shroud assembly (paragraph 3-8) to gain access to the once-around tach assembly alignment lever located on the scanner assembly (Figure 3-14).

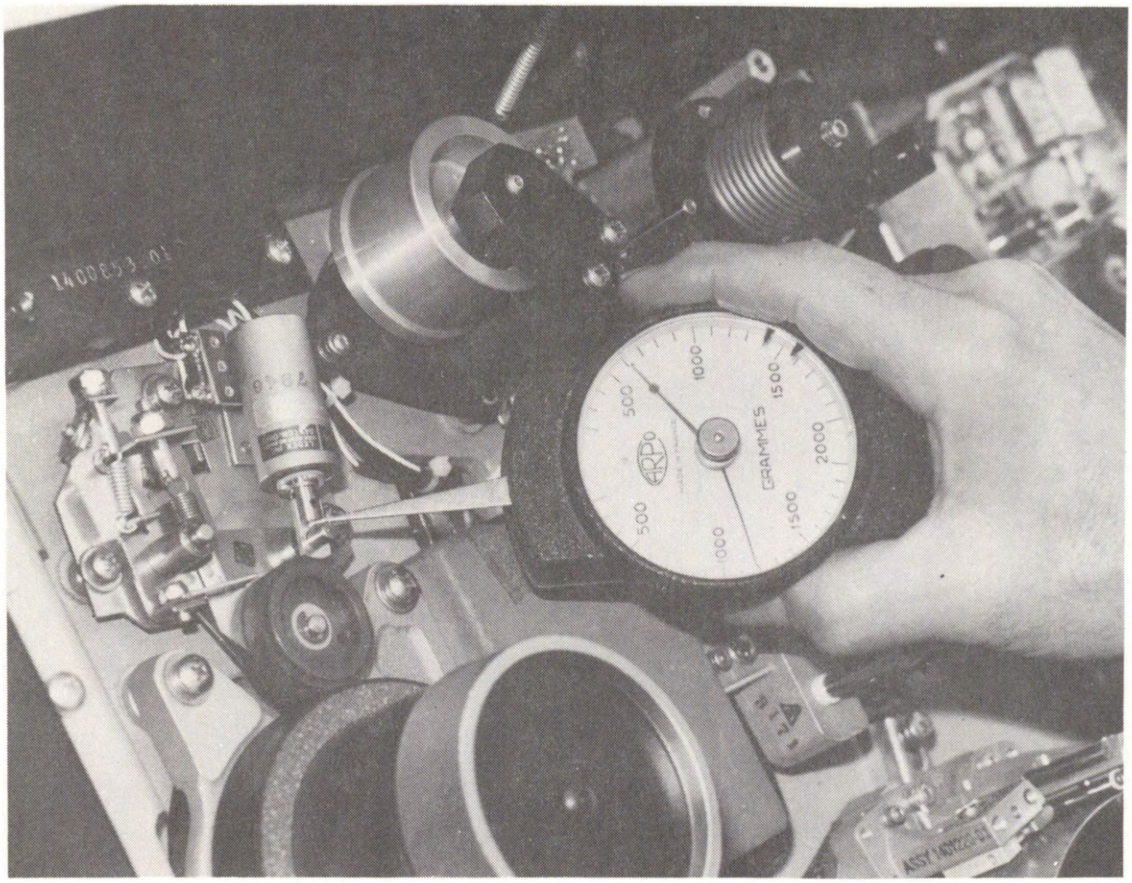


Figure 3-12. Measure Parking Brake Solenoid Spring Tension

2. Set the following switches on the control panel to the positions indicated.

   a. Set TAPE/EE switch to EE.

   b. Set EDITOR switch to ASSEMBLE.

   c. Set VIDEO, AUDIO 1, AUDIO 2, and AUDIO 3 record switches to OFF.

   d. Set AUTO EDIT switch to OFF.

3. Set controls on the PWA's to the positions indicated.

   a. Set SYNC SELECT AUTO/REF/VIDEO switch to AUTO (PWA 12).

   b. Set AUTO/TACH switch to TACH (PWA 11).

   c. Set TRACKING UNITY/VARIABLE switch to VARIABLE (PWA 14).

4. Connect scope to 7TP1 (video monitor out—demodulator output signal). Trigger scope from 14TP2 (14TP3 for 625 version PWA) (frame reference).

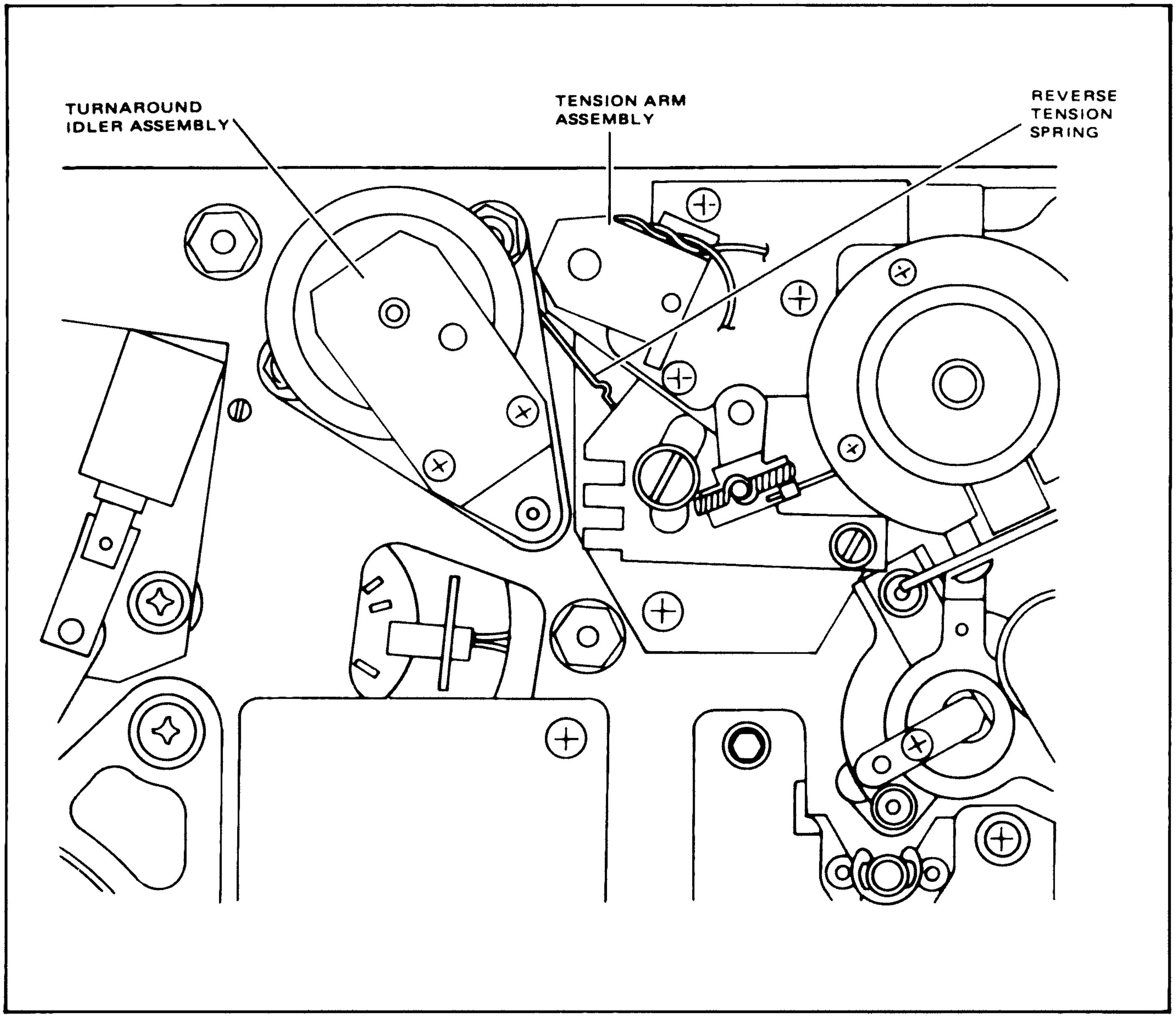


Figure 3-13. Reverse Tension Spring

5. Thread the guide alignment tape (see Table 3-1 for part number) onto the transport.

6. Enter play mode and carefully adjust VAR TRACKING control for the absolute peak indication on the RF LEVEL meter. Enter standby mode.

NOTE

Great care must be taken to determine the absolute peak reading on the rf meter. Improper adjustment of tracking can introduce reading errors in excess of the measurement tolerances. It is recommended that the measurement be performed two or more times to verify repeatability.

7. Use a No. 2-56 hex-head wrench to loosen the serrated lever holddown screw shown in Figure 3-14.

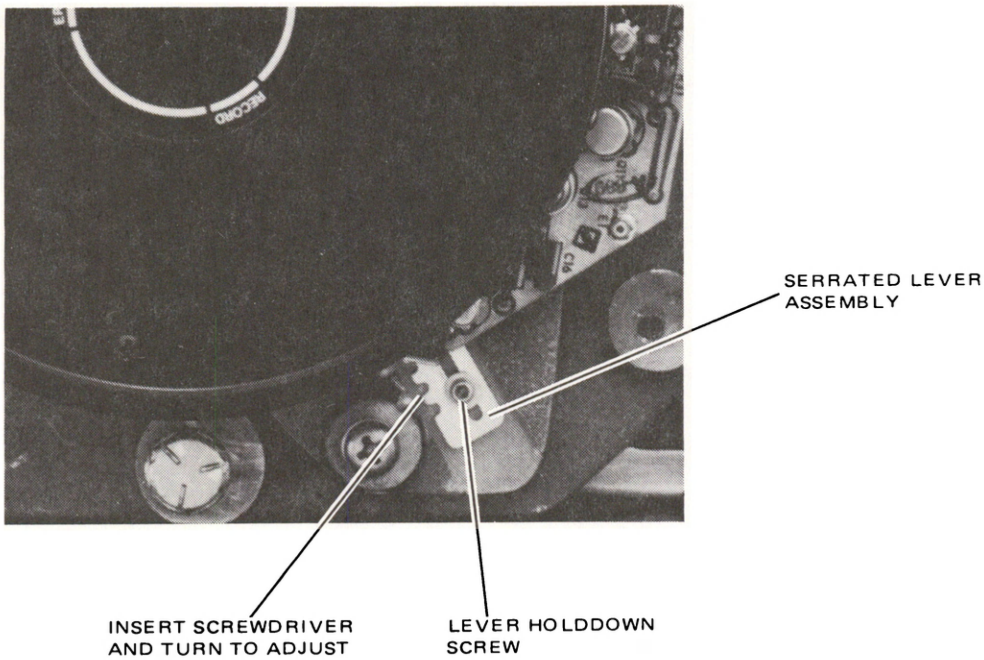


Figure 3-14. Scanner Tach Alignment

8. Expand scope sweep to observe vertical sync area of E-E signal. Adjust scope so sync coincides with a convenient graticule line on scope.

9. Enter play mode and use a screwdriver to adjust the position of the serrated lever assembly so that playback vertical sync matches the E-E vertical sync (observed in step 8) within ±5.0 μs.

10. Switch scope to horizontal rate to observe E-E video lines 16 to 22. Adjust scope so sync coincides with a convenient graticule line on scope.

11. Enter play mode and again adjust position of serrated lever so that playback horizontal sync matches the E-E horizontal sync (observed in step 10) within ±2 μs. Because the demodulated sync will jitter, adjust for the average matched position. After adjusting the tach position, back the serrated lever slightly (in the direction opposite to that of the last movement) before securing the holddown screw loosened in step 7.

12. Tighten the serrated lever holddown screw.

13. Reinstall trim removed in step 1.

3-35. Pin-to-Scanner Gap and Guide Spring Adjustment. The gap between the scanner and the pins of the entrance and exit guides is critical. This gap can affect the beginning and ending of dropout, and dropout duration. For this reason, the pin-to-scanner gap for both guides should be measured, and if necessary, adjusted.

Upon completing this procedure, perform the *Helical Scan Test and Alignment* procedure, paragraph 3-38.

The pin-to-scanner gap procedure requires use of either precision plastic shim stock of 10 mil and 12 mil thickness, or a precision plastic feeler gauge. No metallic feeler gauge or shim stock may be used. The procedure which follows applied to both the entrance and exit guides. The user will apply it to the guide being measured.

3-36. *Pin-to-Scanner Measurement—Entrance and Exit Guides.* Use precision plastic shim stock (10 and 12 mil), or a precision plastic feeler gauge to measure pin-to-scanner gap. Proceed as follows:

1. Remove VPR power and turn scanner so PLAY head is at the 12 o'clock position.

2. Remove transport trim panels and scanner shroud to gain access to guide hardware. Use great care not to damage any scanner heads when removing shroud. Remove guide covers.

3. Turn scanner so no head is near the entrance/exit guides before proceeding (all heads are clear).

4. Prepare to measure pin-to-scanner gap. If precision plastic shim stock is to be used, it must be cut to a suitable size and shape. For ease of handling, the stock material (both 10 mil and 12 mil) may be cut into a wedge 3-inches long; the wedge being 1/2-inch at the wide end, and 1/4-inch at the narrow end, with the narrow end rounded. A precision plastic feeler gauge may be used (instead) if available. Do not use a metal feeler gauge or other metal device in scanner/head area.

CAUTION

DELICATE SCANNER HEADS MUST BE CLEAR OF THE ENTRANCE/EXIT GUIDES BEFORE ATTEMPTING PIN-TO-SCANNER MEASUREMENT OR HEAD DAMAGE MAY RESULT. TURN SCANNER AS REQUIRED.

CAUTION

DO NOT USE A METAL FEELER GAUGE OR OTHER METAL DEVICE IN THE SCANNER OR PIN AREA.

5. Measure pin-to-scanner gap for both the entrance and exit guides. Proceed as follows:

   a. Insert 10-mil precision plastic stock (or plastic gauge) into the gap where the head passes (see Figure 3-15). Insert narrow end first, and from outboard side, not from in between pins. Measurement is valid only where head passes, not above or below. The 10 mil stock (or gauge) should penetrate the gap with little or no clearance.

   b. Repeat step 5a, but using the piece of 12-mil stock (or gauge). The 12-mil piece should not penetrate the gap.

   c. If the pin-to-scanner gap for both guides is correct, proceed to step d. If the gap needs adjustment, proceed to the *Pin-to-Scanner Gap Adjustment* procedure which follows this procedure.

   d. Turn scanner so PLAY head is at the 12 o'clock position. Replace scanner shroud being careful not to damage scanner heads. Replace transport trim removed in step 2. Replace guide covers.

3-37. *Pin-to-Scanner Gap Adjustment.* If the gap for either guide is too great or too small (measured during procedure above), it must be adjusted. Adjust the gap using this procedure, then remeasure to verify that the adjusted gap is correct. This procedure applies to either the entrance or exit guide.

1. Clean the guide block in the area around the base of both guides (Figure 3-15). Use

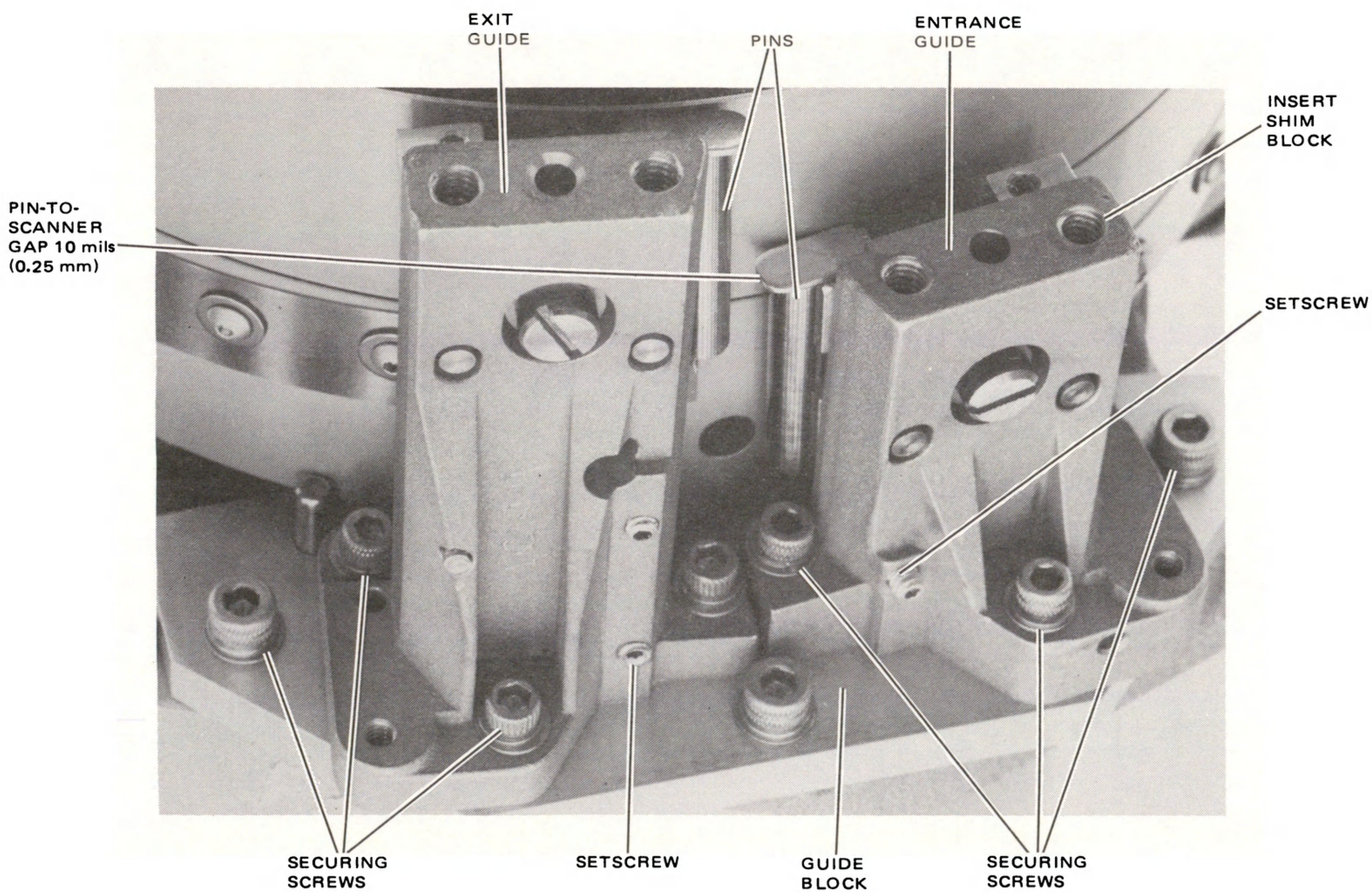


Figure 3-15. Pin-to-Scanner Gap Adjustment

isopropyl alcohol and a Q-tip or small swab. This removes dirt which may get under the guide when moved and cause misalignment.

2. Run the Allen-head setscrew in (turn-clockwise) until it just contacts the base of the scanner. Do not tighten or torque down.

3. Loosen the three screws securing the guide to the guide block.

4. Adjust gap:

   a. The guide may tend to be frozen into its position. To unseat the guide, back out the setscrew (Figure 3-15) about one turn, then press the guide in at the base and observe that it moves in. (Note that it pivots on the dowel pressed into the guide block.) Now that the guide moves freely, tighten the setscrew about one turn to restore the guide to the original gap value (approximately).

   b. Set gap. Turn setscrew clockwise slightly to increase gap; turn counterclockwise slightly to decrease gap. Press in guide gently at base so setscrew tip contacts scanner.

   c. Secure guide. While holding guide in at the base, snug the three securing screws down gently. Before cinching screws, check gap with plastic shim stock (or plastic gauge) to see that it is close to the proper gap measurement (the gap may change when the screws are tightened). Loosen screws and readjust is necessary. When the gap is correct, tighten the screws little by little—going from one to the other, until they are all tight and secure. Recheck the gap; if incorrect, loosen the securing screws and repeat steps 4b and 4c.

5. When adjustment is complete, back out the setscrew about two turns so it is clear of the scanner. This prevents it from "digging in" should the guide block itself be moved or adjusted.

6. Check that spring-loaded ceramic-edge tape guide on top of the exit guide pin is flush with the edge of the pin (side that faces drum) or is within no less than 0.003 inch (0.076 mm) from the drum. If necessary, loosen Phillips head screw that secures the spring and keeper. Reposition the spring and keeper and retighten the screw.

7. Refer to Figure 3-16 while performing this step. Check that the spring-loaded ceramic-edge guide sits squarely (parallel) on top of the guide pin. Also check that a 0.282-ounce (8-gram) minimum force is required to lift tape guide from top of guide pin. If necessary, remove keeper and spring and guide assembly (one screw) and carefully bend (very light twisting motion) spring leaf so tape guide is parallel on top of guide pin. To adjust spring pressure, bend spring leaf at existing bend that is near screw hole. Reinstall keeper and spring and guide assembly (one screw), and recheck requirements of steps 6 and 7.

8. Turn scanner play head to 12 o'clock position. Replace scanner shroud, being careful not to damage a head. Replace transport trim panels and guide covers.

9. Retighten screws loosened in step 2. Recheck requirements of steps 5 and 6.

10. Reinstall exit guide cover (one screw).

3-38. Helical Scan Test and Alignment. For video tape recordings to be interchangeable among all Type C 1-inch helical VTR's, the helical path described by the video head as it scans the tape must be the same on one machine as it is on the next. The helical path is determined primarily by the factory-set helical guide band on the lower scanner, but is also affected by the adjustable entrance and exit guides. These guides influence the position and attitude of the tape as it begins and ends its wrap around the scanner. The helical alignment is checked by comparing video head tracking to the tracking standard provided on a guide alignment tape (see Table 3-1 for proper alignment tape type).

3-39. *Noise-Free Interval Test.* A method for analyzing head tracking is to measure the noise-free interval time. This time is the total amount of

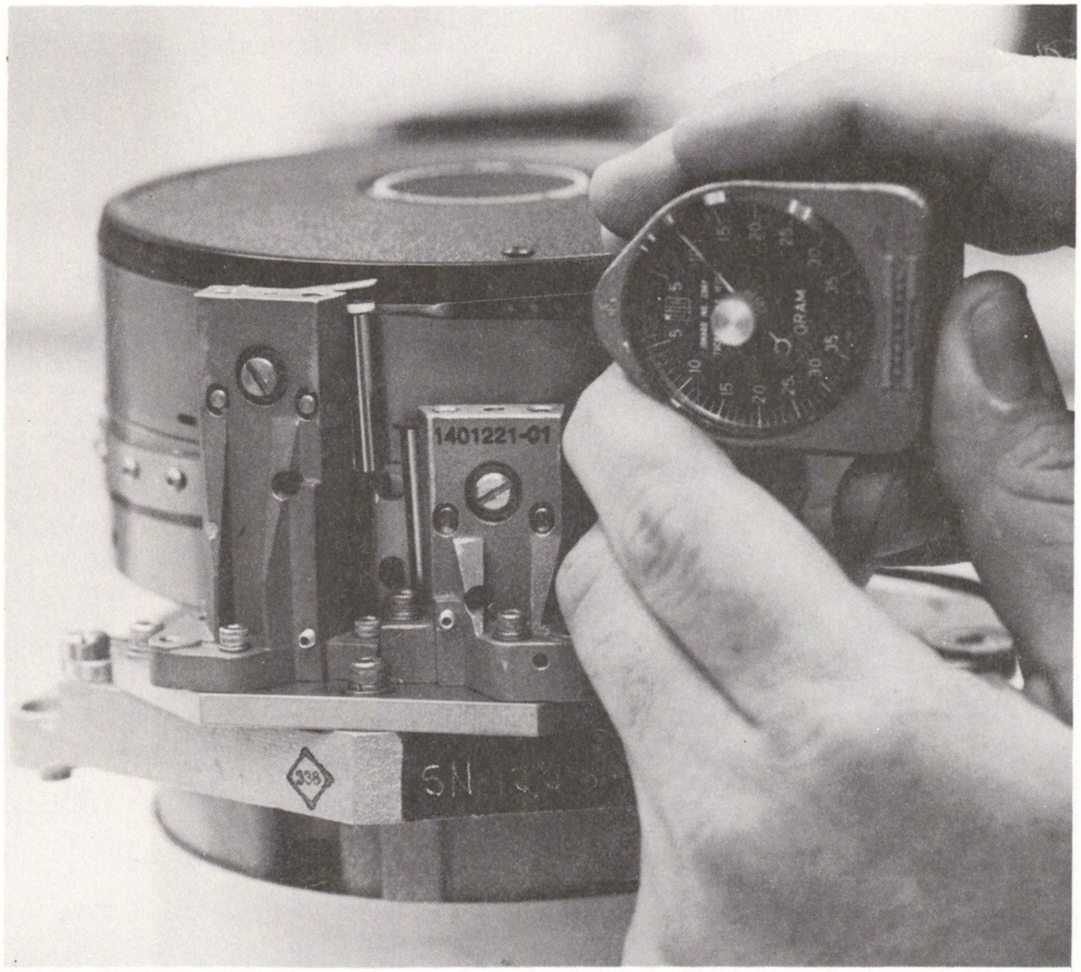


Figure 3-16. Measure Scanner Exit Guide Spring Pressure

time that the video head can be moved with relation to the control track pulses and not pick up video from either adjacent video track. The VAR TRACKING control is used to vary the timing and, when using the guide alignment tape, crossover of the video head into an adjacent track is evidenced by breakup or interference in the picture in the monitor display. To measure the noise-free interval time, proceed as follows:

1. Clean the scanner, heads, guides, and capstan as described under *Preventive Maintenance*. Demagnetize all tape path components.

2. Use a "work" tape to check that holdback tape tension is between 4.0 and 4.5 ounces (112 to 126 grams). Refer to *Tape Tension Measurement and Adjustment* procedures, paragraph 3-29, if necessary.

3. Thread the guide alignment tape (Table 3-1) onto the transport.

4. Set the following switches on the control panel to the positions indicated.

   a. Set TAPE/EE switch to EE.

b. Set EDITOR switch to ASSEMBLE.

c. Set VIDEO, AUDIO 1, AUDIO 2, and AUDIO 3 record switches to OFF.

d. Set AUTO EDIT switch to OFF.

5. Set controls on the PWA's to the positions indicated.

a. Set SYNC SELECT AUTO/REV/VIDEO switch to AUTO (PWA 12).

b. Set AUTO/TACH switch to TACH (PWA 11).

c. Set TRACKING UNITY/VARIABLE switch to VARIABLE (PWA 14).

6. Connect scope probe to 8TP4 (8TP2 on non-AST version PWA's) (record head playback) and trigger scope from 14TP2 (14TP3 on 625 version PWA's) (FRAME REF).

7. Place recorder into play mode, and adjust VAR TRACKING control for best video picture.

8. Adjust scope to display rf envelope for one field (Figure 3-17).

9. Turn VAR TRACKING control until picture on monitor just begins to deteriorate; return control to borderline area where picture looks good.

10. Adjust scope so that edge of rf presentation is at a convenient reference point with respect to the scope graticule.

11. Turn VAR TRACKING control in the opposite direction to that of step 9 until picture again begins to deteriorate. Return control to borderline area where picture looks good.

12. Measure displacement (time shift) of rf envelope on scope to determine the noise-free interval time. The time should be at least 8.0 ms.

13. Observe that when VAR TRACKING control is turned from maximum rf position, the rf envelope shows uniform collapse. Breathing, undulations, and fluctuations in the rf envelope should be no more than 10% of the envelope amplitude.

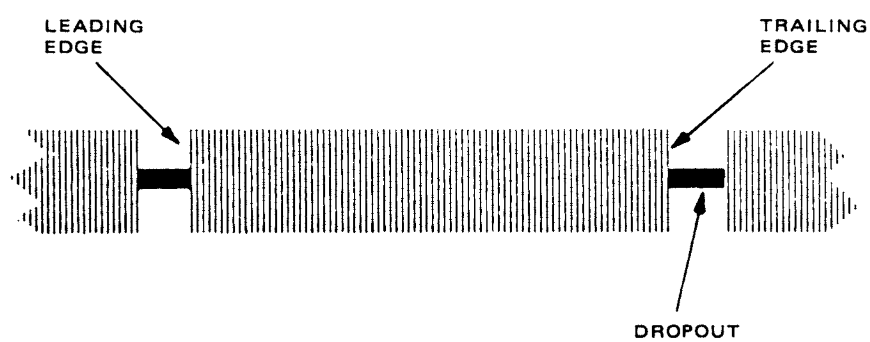


Figure 3-17. Ideal Interchange RF Envelope

14. If the preceding noise-free interval test was not within specifications, perform the following *Scanner Entrance and Exit Guide Alignment Procedure*.

3-40. *Scanner Entrance and Exit Guide Alignment Procedure.* Adjusts "A" and "B" adjust the angle of the guide pins and adjustments "C" and "D" set the guide pin height (Figure 3-18).

The entrance-guide guide pin is tapered whereas the exit-guide guide pin is straight. Figure 3-19 shows an ideal rf envelope with adjustments "A" and "B" correctly set as well as the appearance of the envelope with adjustment "A" incorrectly set.

The adjustment screws designated "C" and "D" are factory set to provide approximately a 0.005-inch clearance between the tape and the keeper and should not require readjustment following minor adjustment of screws "A".

The upper keeper should not contact the upper tape edge in normal operating modes and is present only to prevent tape damage, particularly during tape unthreading. To adjust the entrance- and exit-guide pins, proceed as follows:

1. Remove the exit-guide cover and the entrance guide cover by removing one screw that secures each cover.

2. Unlock the entrance-guide adjustment locking screw and exit-guide adjustment locking screw (Figure 3-18) one-quarter turn counterclockwise.

3. Slowly rotate VAR TRACKING control back and forth to check that the leading and

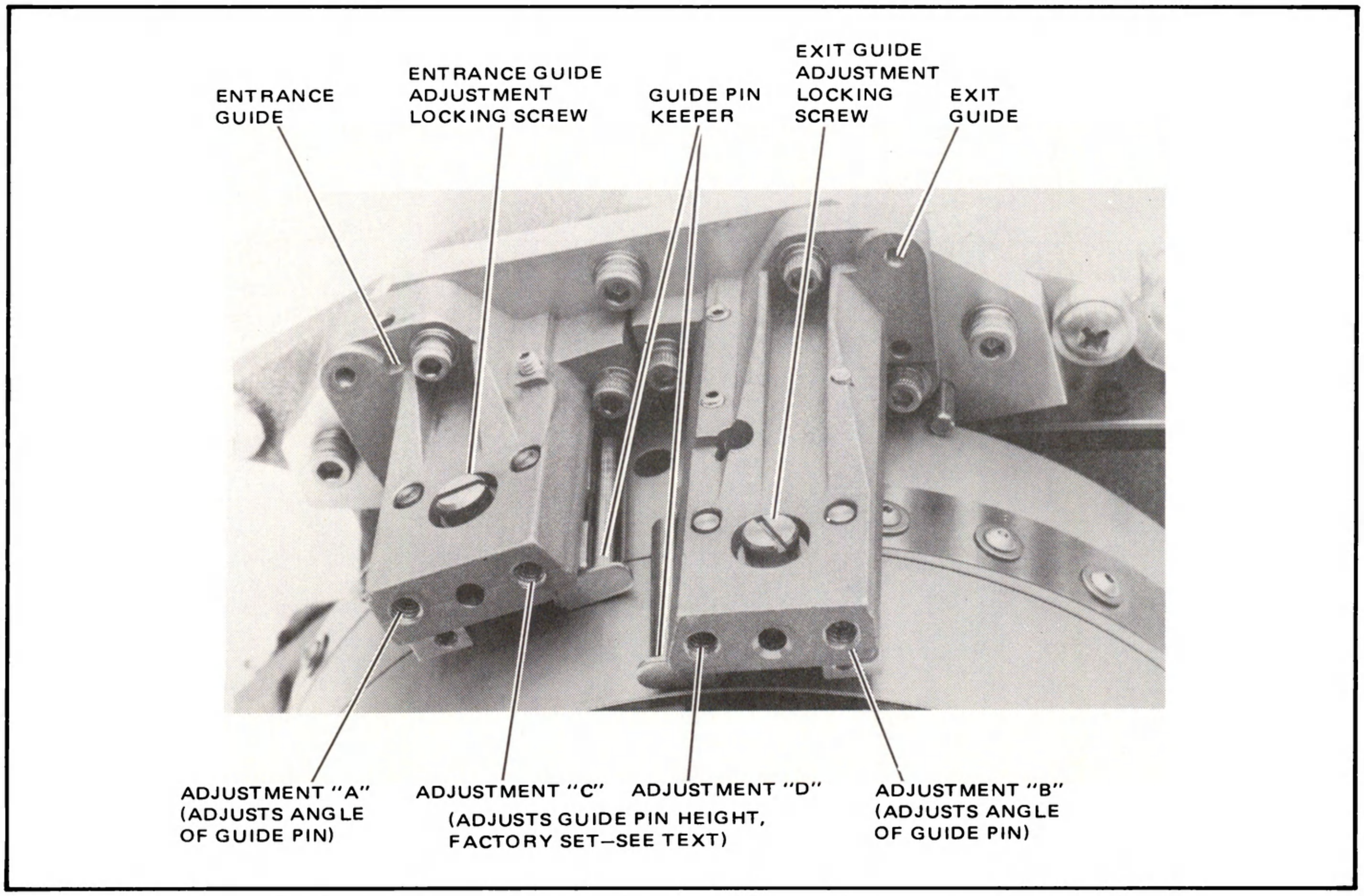


Figure 3-18. Entrance- and Exit-Guides Adjustment Screws, Scanner Assembly

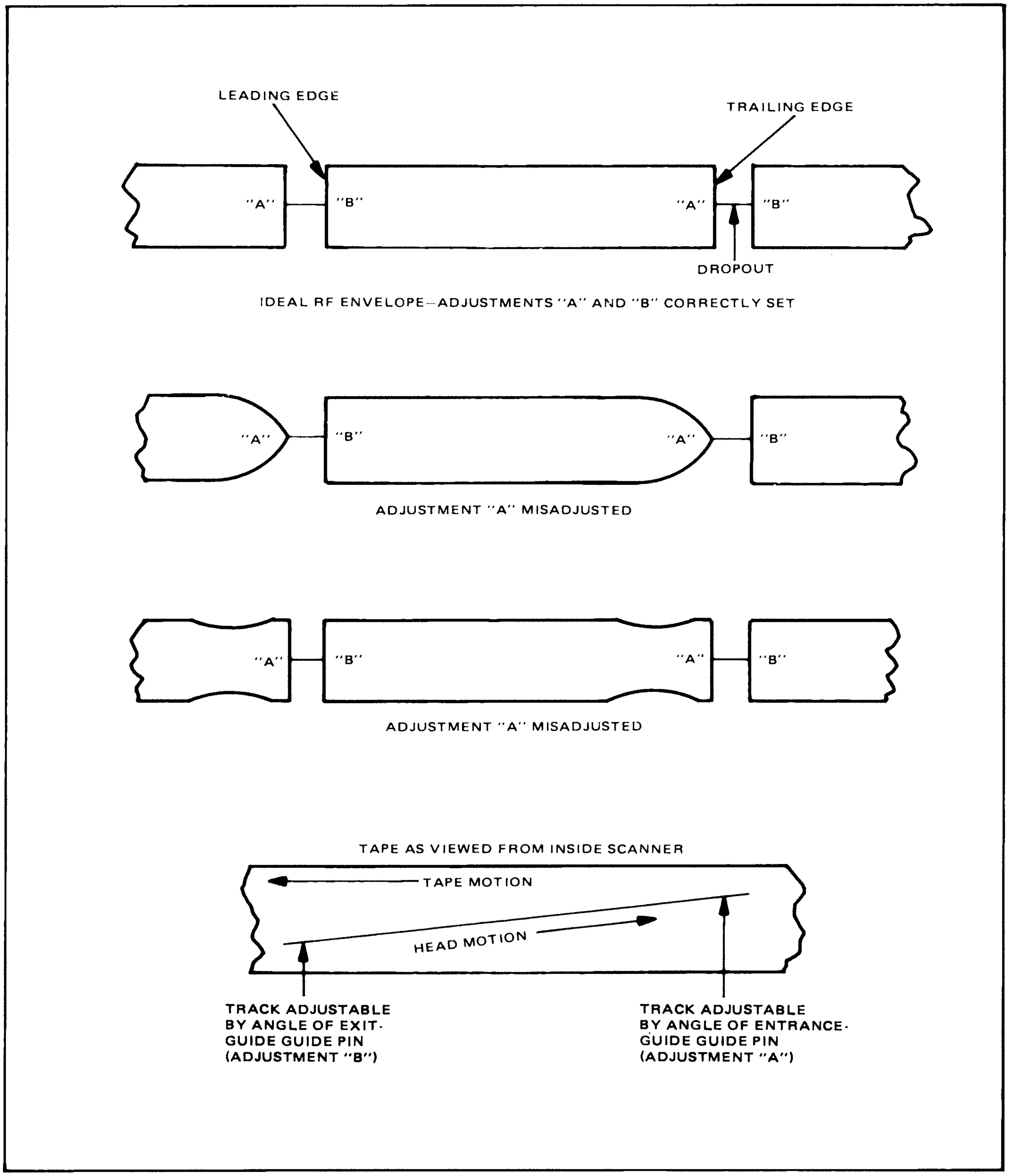


Figure 3-19. Effects of Helical Alignment Adjustments on Video Tracking

trailing edges of the rf envelope rise and fall at the same amplitude. Adjust the tilt angle of the entrance- and exit-guide guide pins (adjustments "A" and "B" in Figure 3-19) for maximum output and flatness at the leading and trailing edges of the rf envelope, as shown in Figure 3-19. Repeat this step as required.

4. While in play mode, observe that there is approximately 0.005 inch (5 mil) clearance between the upper edge of the tape and the keeper on the entrance guides. Adjust screws "C" and "D" if required.

NOTE

If screws "C" and "D" are adjusted, step 3 must be repeated.

5. Tighten the entrance- and exit-guide adjustment locking screws loosened in step 2, and repeat step 3 to ensure that adjustment has not changed after tightening screws.

6. Perform steps 3 through 13 of the *Noise-Free Interval Test*, paragraph 3-39.

7. Reinstall exit- and entrance-guide covers removed in step 1.

3-41. Helical Scan Dropout. Video dropout begins when the rotating video record head leaves the tape near the scanner entrance guide and ends as the head begins its scan on tape just past the exit guide. The duration of the dropout is factory set (by placement of the guides on the scanner guide block) to be nominally 10 horizontal lines wide (635 μs) NTSC or 11.9 horizontal lines wide (760 μs) PAL. Dropout duration increases with head wear, which causes shifting of the dropout position with respect to the vertical blanking interval. Lateral positioning of the guide block is provided to allow adjustment of the beginning of dropout relative to the leading edge of the third or fourth vertical-sync broad pulse. Table 3-7 shows the relationship between head-tip projection, dropout duration, and the relative coincidence of dropout to the third or fourth broad pulse. As can be seen in the table, nominal dropout width for a video head with 0.0024-in. tip projection is 635 μs (760 μs PAL) and starts –0.1 μs (19.0 μs) after the leading edge of the third (NTSC) or fourth (PAL) broad pulse.

NOTE

If the dropout starts at the wrong point, perform the *Scanner Tach Alignment* procedure, paragraph 3-34, to verify alignment is correct.

When a replacement video head is installed, the tip projection will be within a range of 0.0030 in. to 0.0036 in., and the beginning of dropout should occur within 15 μs of the appropriate time as given in Table 3-7. If a tip projection measurement cannot be performed upon replacement with a new head, assume a 0.0033-in. tip projection. Measure head-tip projection using the *Video/Sync Head Tip Projection Measurement procedure below.*

3-42. Video/Sync Head Tip Projection Measurement. Use this procedure to measure tip projection using the Tip Projection Gauge, Ampex Part No. 1401000.

1. Using head cleaner, clean the heads, upper scanner surface, and tip projection gauge contacting surfaces and rollers (see Table 3-1 for cleaner type). Use care not to damage head tips.

2. Remove scanner cover.

3. Turn tape roller on underside of tip projection gauge clockwise one-quarter turn (Figure 3-20) to place virgin leader tape over the measurement tip.

4. Turn scanner so video head (AST head) is at 1 o'clock position.

NOTE

The tip projection gauge measurement tip must not contact any scanner head during gauge installation or head damage may occur. Position scanner so no contact results.

5. Install tip projection gauge:

   a. Grasp gauge as shown in Figure 3-21. Compress spring with left hand.

Table 3-7. Dropout Timing

NTSC			PAL/SECAM		
TIP PROJECTION (INCHES)	DROPOUT DURATION (μs ±15 μsec)	DROPOUT START ± START OF 3rd BROAD PULSE (μs ±15 μsec)	TIP PROJECTION (INCHES)	DROPOUT DURATION (μs ±15 μsec)	DROPOUT START AFTER START OF 4th BROAD PULSE (μs ±15 μsec)
0.0012	670.0	-6.5	0.0012	803.0	11.8
0.0013	667.0	-6.0	0.0013	800.0	12.4
0.0014	664.0	-5.5	0.0014	796.0	13.0
0.0015	661.0	-4.9	0.0015	792.0	13.6
0.0016	658.0	-4.4	0.0016	789.0	14.2
0.0017	655.0	-3.9	0.0017	785.0	14.8
0.0018	652.0	-3.3	0.0018	782.0	15.4
0.0019	649.0	-2.8	0.0019	778.0	16.0
0.0020	646.0	-2.3	0.0020	775.0	16.6
0.0021	644.0	-1.7	0.0021	772.0	17.3
0.0022	641.0	-1.2	0.0022	768.0	17.8
0.0023	638.0	-0.6	0.0023	765.0	18.4
0.0024	635.0	-0.1	0.0024	761.0	19.0
0.0025	632.0	0.4	0.0025	758.0	19.6
0.0026	629.0	1.0	0.0026	754.0	20.2
0.0027	626.0	1.5	0.0027	751.0	20.8
0.0028	623.0	2.0	0.0028	747.0	21.4
0.0029	620.0	2.6	0.0029	744.0	22.0
0.0030	617.0	3.0	0.0030	740.0	22.6
0.0031	614.0	3.5	0.0031	736.0	23.2
0.0032	612.0	4.0	0.0032	733.0	23.8
0.0033	609.0	5.0	0.0033	730.0	24.4
0.0034	606.0	5.5	0.0034	726.0	25.0
0.0035	604.0	6.0	0.0035	724.0	25.6
0.0036	601.0	6.5	0.0036	720.0	26.2

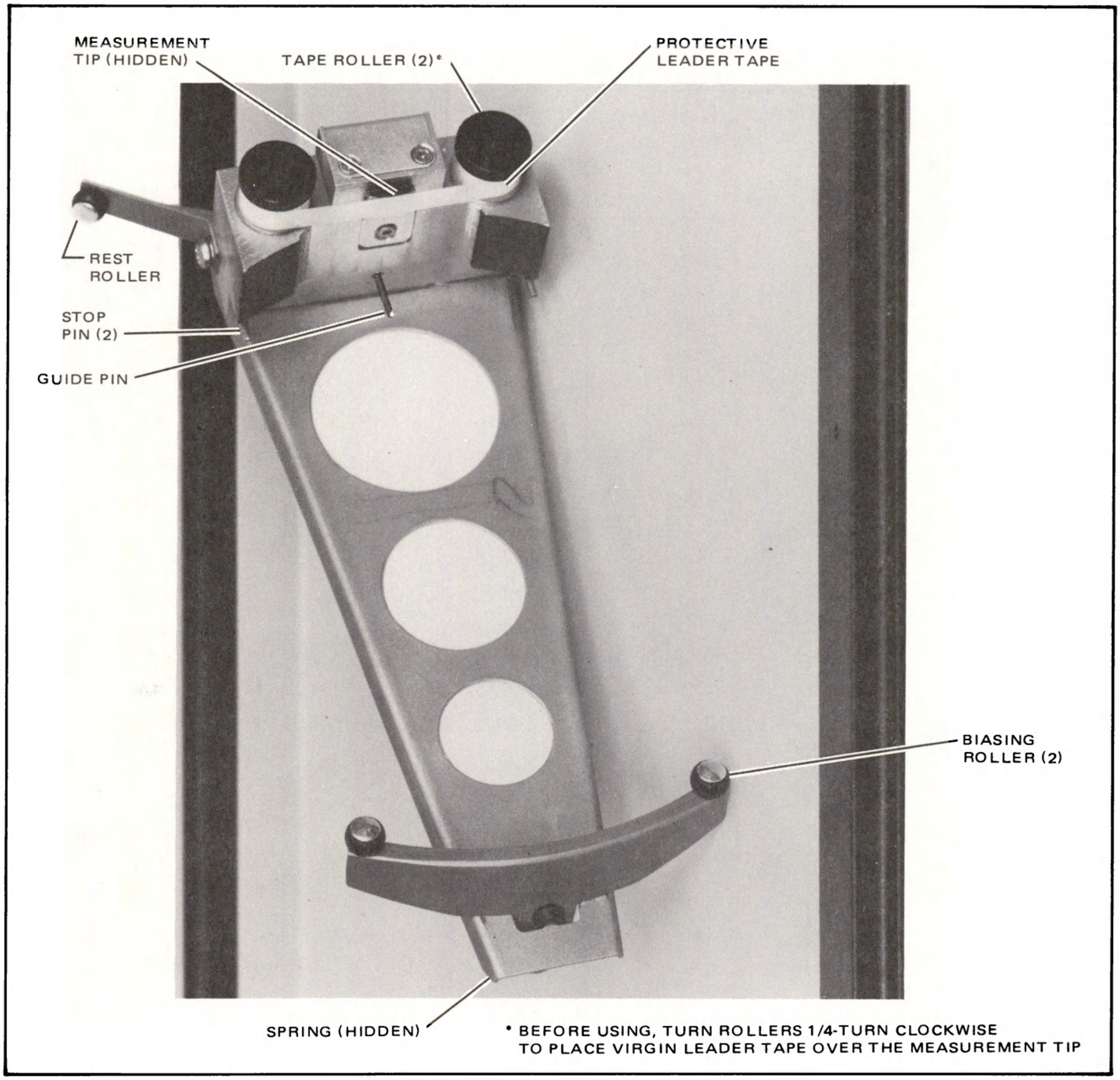


Figure 3-20. Tip Projection Gauge, Bottom View

b. Position gauge over scanner (Figure 3-21) and seat it squarely on the upper scanner top. The guide pin and the biasing rollers will be in contact with the scanner top and surface (see underside of gauge, Figure 3-20).

c. Release spring and allow biasing rollers to clamp the scanner, biasing it into the proper position.

d. Allow the weight of the gauge to turn the scanner until the rest roller (Figure 3-22)

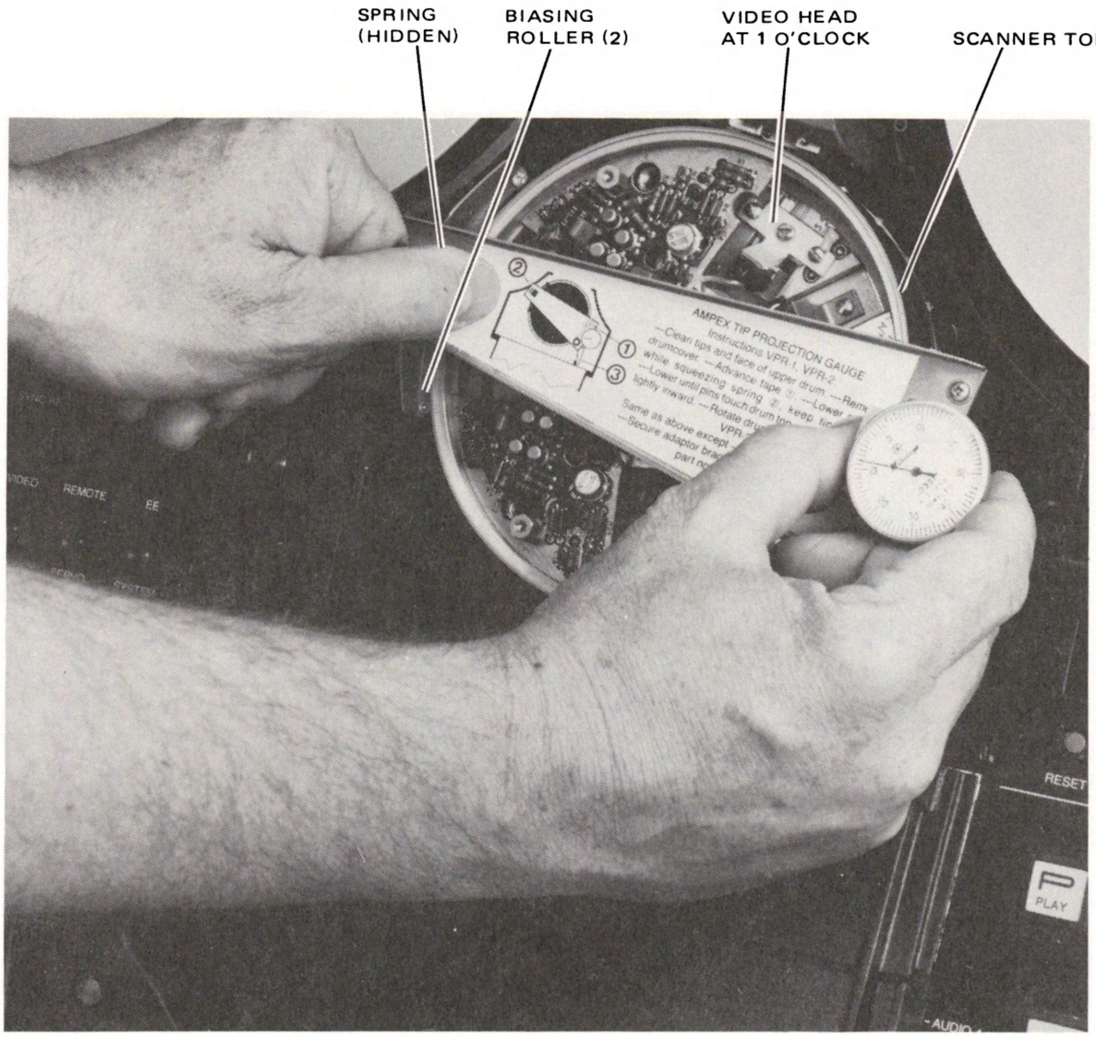


Figure 3-21. Installing Tip Projection Gauge on Scanner

contacts the scanner shroud. Push gauge inward toward transport lightly to ensure gauge is seated squarely and that the guide pin contacts the scanner top.

6. Zero the gauge:

   a. Rotate upper scanner clockwise (approximately one turn) until the gauge stabilizes. Turn scanner using fingers (as shown in Figure 3-22). Do not touch the gauge itself or outer scanner surface.

   b. Set gauge to zero. Turn the gauge outer ring as shown in Figure 3-23. Note that the gauge must be resting in an area between heads (not on top of one) to correctly zero the meter.

Figure 3-22. Measuring Tip Projection

7. Measure tip projection:

   a. Rotate upper scanner clockwise slowly to measure tip projection for all scanner heads. Figure 3-22 shows this process and a resulting tip measurement of 3.4 mils (0.0034 inches). (Note: Divide meter reading by ten to obtain measurement in mils.)

8. Restore system:

   a. Turn scanner so gauge reads zero. This assures that it is clear of all scanner heads to avoid possible damage.

   b. Remove gauge by compressing spring and lifting free of scanner. Place gauge in its

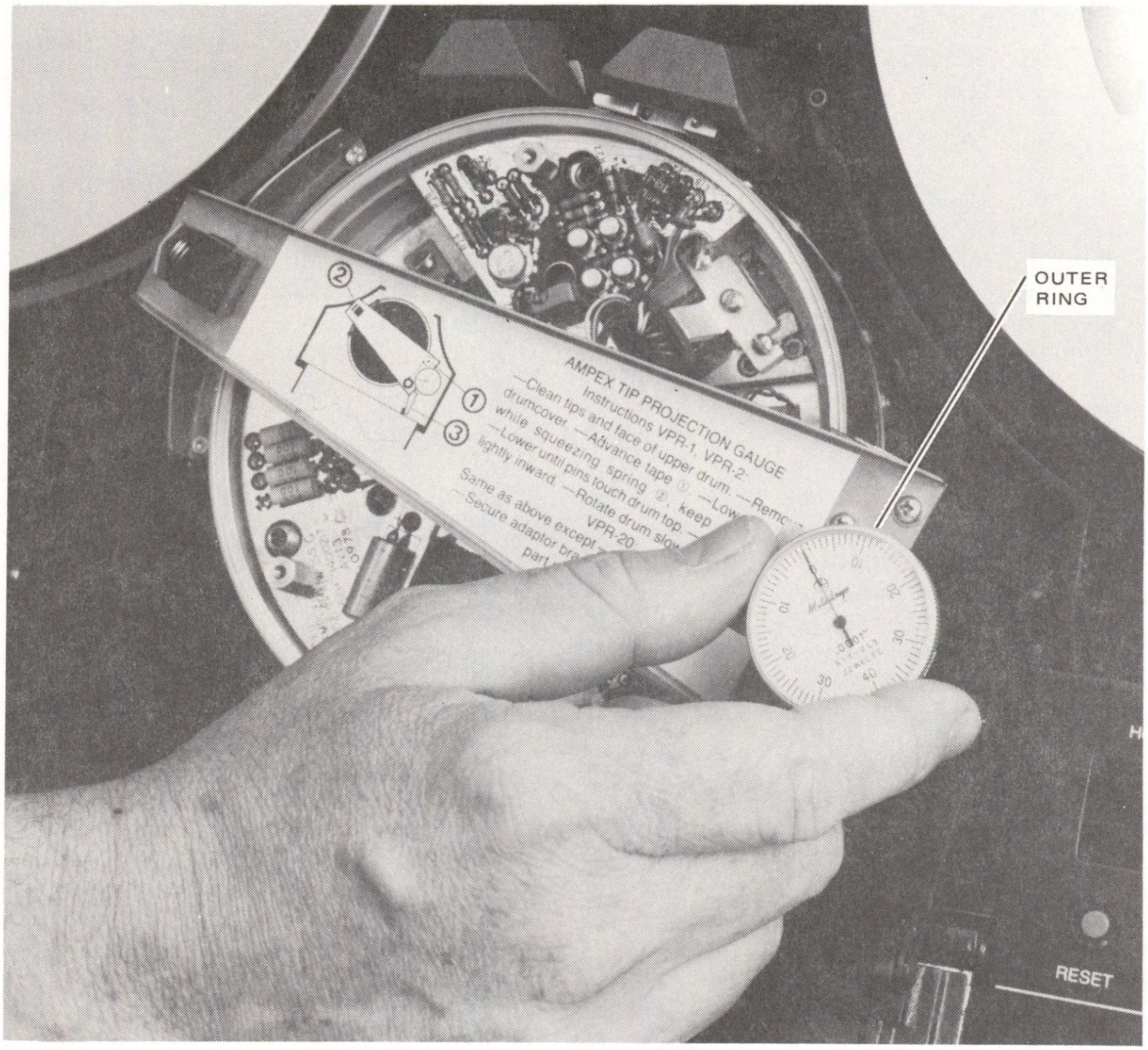


Figure 3-23. Zeroing the Gauge

protective box to ensure it does not get dropped or otherwise misaligned.

c. Replace scanner cover.

3-43. *Dropout Duration and Position Measurement.* To determine dropout duration and position, proceed as follows:

1. Set the following switches on the control panel to the position indicated.

a. Set TAPE/EE switch to EE.

b. Set EDITOR switch to OFF.

c. Set VIDEO record enable switch to ON.

d. Set AUTO EDIT switch to OFF.

2. Set controls on the PWA's to the positions indicated.

   a. Set SYNC SELECT AUTO/REF/VIDEO switch to AUTO (PWA 12).

   b. Set AUTO/TACH switch to TACH (PWA 11).

   c. Set TRACKING UNITY/VARIABLE switch to UNITY (PWA 14).

3. Connect channel 1 of scope to 8TP4 (record head playback) and connect channel 2 of scope to 7TP1 or video monitor out, VPR rear panel (video monitor out—demodulator output signal). Trigger scope from 14TP2 (14TP3 for 625 version PWA's) (frame reference).

4. Thread tape onto transport, make a short recording, and rewind the tape.

5. Set EDITOR switch to INSERT (so record head will play back recording) and enter play mode.

6. Set scope for expanded sweep to view vertical blanking area of field 1 (channel 2). Dropout duration is that period of time in which the rf amplitude is 50% or less (6 dB down) than normal rf amplitude as shown in Figure 3-24 (channel 1). Then, measure and record the dropout position with respect to the nominal position (defined below). Note that 0.001 inches (1 mil) of adjustment equals 1.0 microsecond of dropout position change (Note: 1 mil equals 0.0254 mm). A nominal position is defined as the beginning of dropout that will start a certain number of microseconds into the third broad pulse (SMPTE) or fourth broad pulse (EBU) depending on the tip projection of the record head. Table 3-7 provides the nominal value based upon tip projection measured.

   For example, if the dropout (PAL) is 730 μs wide, it should start 24.4 μs (± 15 μs) after the leading edge of the fourth broad pulse. If the dropout position error is in excess of ± 15 μs, then the guide block should be repositioned as described in the *Dropout Position Adjustment* procedure immediately below.

3-44. *Dropout Position Adjustment.* To adjust the position of the dropout, proceed as follows:

CAUTION

MAKE ALL MECHANICAL ADJUSTMENTS WHEN POWER IS OFF AND SCANNER IS NOT ROTATING. OTHERWISE, DAMAGE TO HEADS CAN OCCUR.

1. Remove transport trim and the scanner shroud assembly (paragraph 3-8) to gain access to the scanner guide block securing screws (Figure 3-25).

2. Determine from the previous *Dropout Duration and Position Measurement* procedure (paragraph 3-43) the amount of dropout

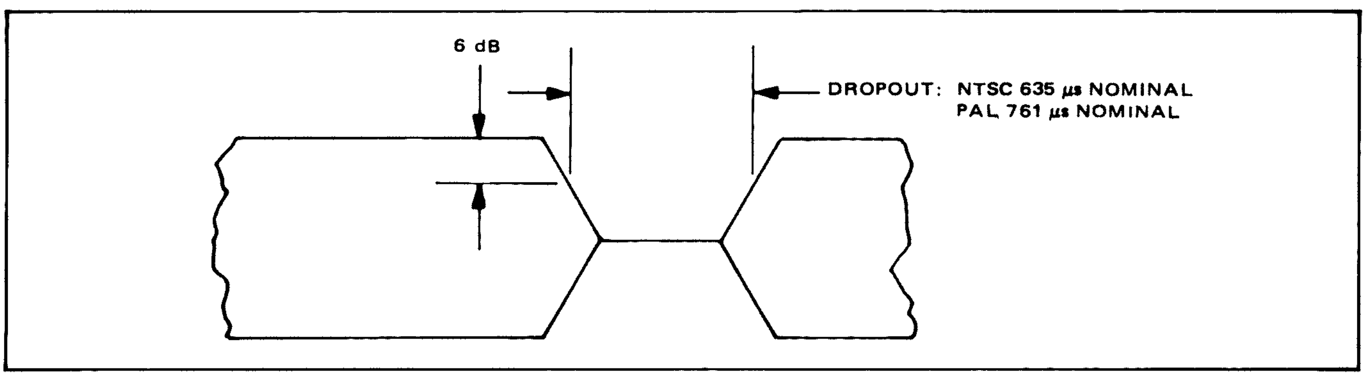


Figure 3-24. Dropout Duration, Record Head RF Playback

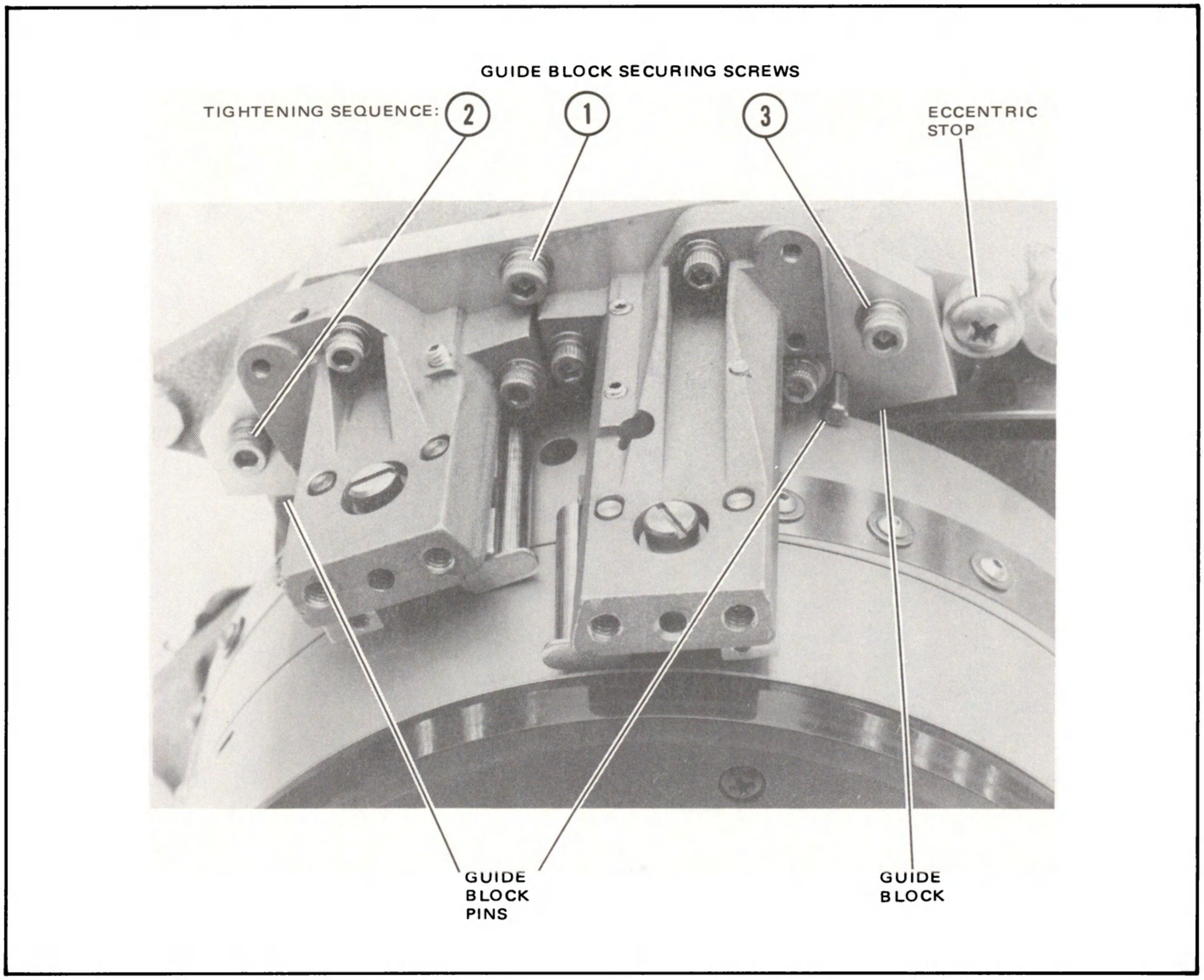


Figure 3-25. Dropout Position Adjustment

position error, and whether the dropout appears early or late. If the dropout is late (in excess of 15 μs), the guide block must be moved to the left. If the dropout is early (less than 15 μs), the guide block must be moved to the right. One mil of guide block movement is equal to 1 μs. (Note: 1 mil equals 0.0254 mm.)

NOTE

Note the eccentric stop and lockscrew located to the right of the guide block plate (Figures 3-25 and 3-26). The eccentric stop is used as a reference to adjust the guide block position and, after adjustment, permits the same guide block to be removed from the scanner and reinstalled without the need for dropout position readjustment.

3. If the dropout is early, the guide block must be moved to the right as follows:

   a. Loosen the screw that secures the eccentric stop and use a feeler gauge to set the spacing

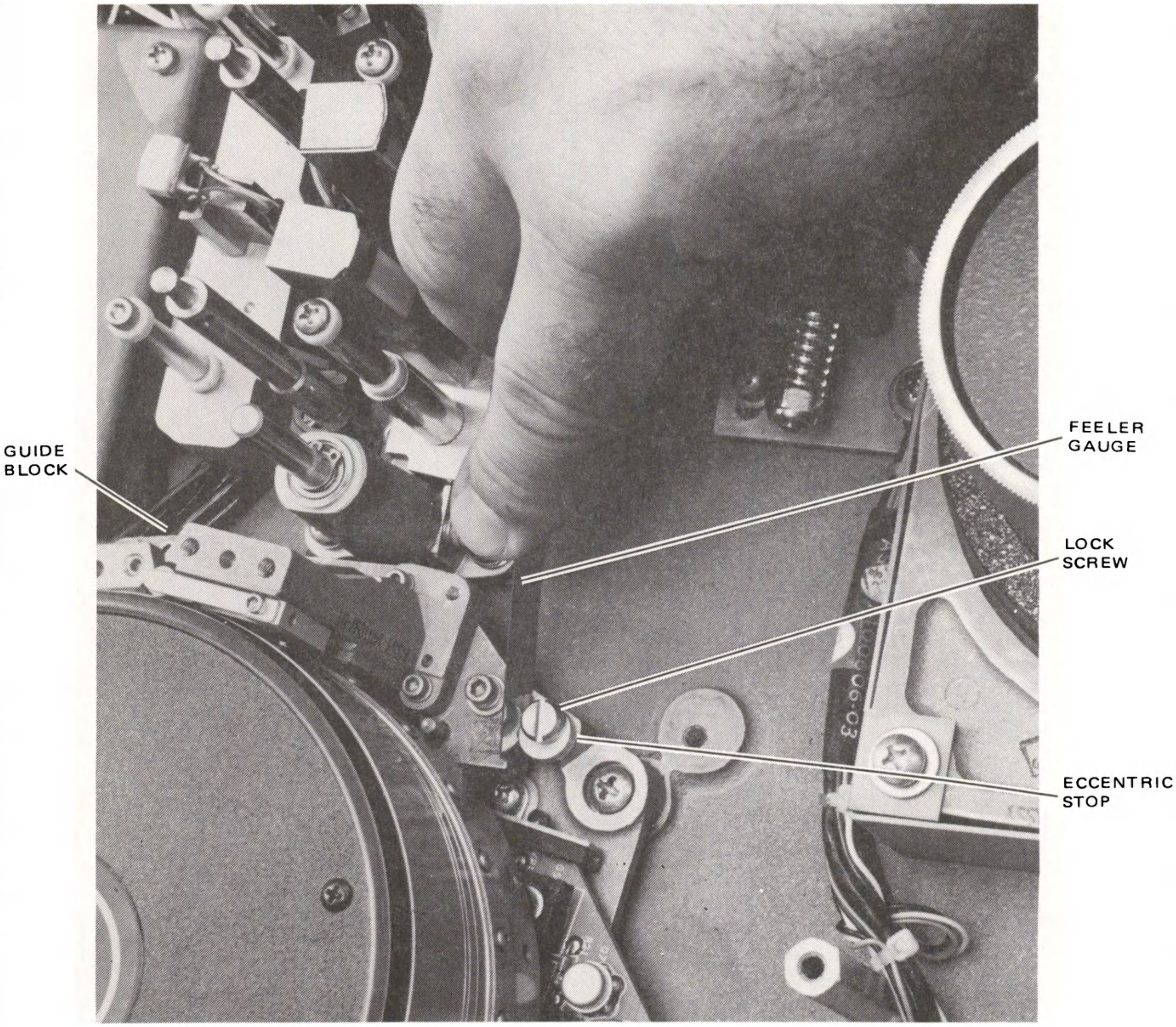


Figure 3-26. Adjusting Dropout Position

in mils (1 mil equals 1 μs) between the eccentric stop and the guide block (see Figure 3-26). Tighten the eccentric stop screw.

b. Loosen the three hex-head screws that secure the guide block to the scanner casting.

c. Slide the guide block to the right so that the guide block edge is pressed against the eccentric stop and the guide block locating pins are resting against the lower scanner. Then tighten the three hex-head screws according to the tightening sequence noted in Figure 3-25. Do not fully tighten any

one screw on the first pass. It is recommended that three tightening passes be made before full torque is applied.

4. If the dropout is late, the guide block must be moved to the left as follows:

   a. Loosen the three hex-head screws that secure the guide block to the scanner casting. Slide the guide block to the left and use a feeler gauge to set the spacing between the eccentric stop and the guide block (see Figure 3-26).

   b. While maintaining the spacing set in step 4a, press the guide block locating pins against the lower scanner and tighten the three hex-head screws according to the tightening sequence noted in Figure 3-25. Do not fully tighten any one screw on the first pass. It is recommended that three tightening passes be made before full torque is applied.

   c. Loosen the screw that secures the eccentric stop and rotate the eccentric stop against the guide block. Then tighten the eccentric stop screw.

5. Make a new recording, then determine dropout position while playing back the new recording. Repeat either step 3 or 4, as applicable, each time making a new recording until dropout position error is within ±15 μs. Verify dropout duration on each recording to be certain the guide block pins are properly resting against the scanner surface.

   Repeat the *Dropout Duration and Position Measurement*, paragraph 3-43, and the *Scanner Tach Alignment* procedure, paragraph 3-34, to verify that they have not changed.

6. Reinstall transport trim and scanner shroud assembly.

3-45. Control Track Head Phase Adjustment. If the scanner assembly has been changed, the phase of the control track pulses relative to the recorded video should be checked and, if necessary, adjusted. The adjustment is made by optimizing the position of the right-hand longitudinal head assembly mounting block on the transport.

NOTE

The *Scanner Tach Alignment Procedure,* paragraph 3-34, must be performed and its parameters satisfied before beginning this procedure.

1. Set the following switches on the control panel to the positions indicated.

   a. Set TAPE/EE switch to EE.

   b. Set EDITOR switch to ASSEMBLE.

   c. Set VIDEO, AUDIO 1, AUDIO 2, and AUDIO 3 record switches to OFF.

   d. Set AUTO EDIT switch to OFF.

2. Set controls on the PWA's to the positions indicated.

   a. Set SYNC SELECT AUTO/REF/VIDEO switch to AUTO (PWA 12).

   b. Set AUTO/TACH switch to TACH (PWA 11).

   c. SET TRACKING UNITY/VARIABLE switch to UNITY (PWA 14).

3. Connect scope to 7TP1 or to video monitor out, VPR rear panel (video monitor out—demodulator output signal). Trigger scope from 14TP2 (14TP3 for 625 version PWA's) (frame reference).

4. Thread the guide alignment tape (see Table 3-1 for Ampex part number) onto the transport.

5. In STOP mode use expanded sweep to observe the front porch of vertical sync. Note which field is being observed and then adjust scope to view the back porch of vertical sync.

6. Enter playback mode and observe the same field as in step 5. The playback video should match the EE video within ±15.0 μs, as observed at the vertical back porch. If the timing is not within ±15.0 μs, perform step 7.

7. Adjust the position of the right-hand longitudinal head assembly as follows:

   a. Remove audio head cover and transport trim (paragraph 3-8) to gain access to the head assembly mounting screws.

   b. Loosen socket-head screw that secures the stop to the flutter idler casting (Figure 3-27). This stop provides positioning repeatability should either head stack be replaced.

   c. Loosen the three hex-head securing screws.

   NOTE

   The center securing screw should be loosened only 1/2-turn to avoid head stack tilt.

   d. Perform steps 5 and 6; while playing back the alignment tape, move the head assembly in a direction toward or away from the capstan so that the timing is

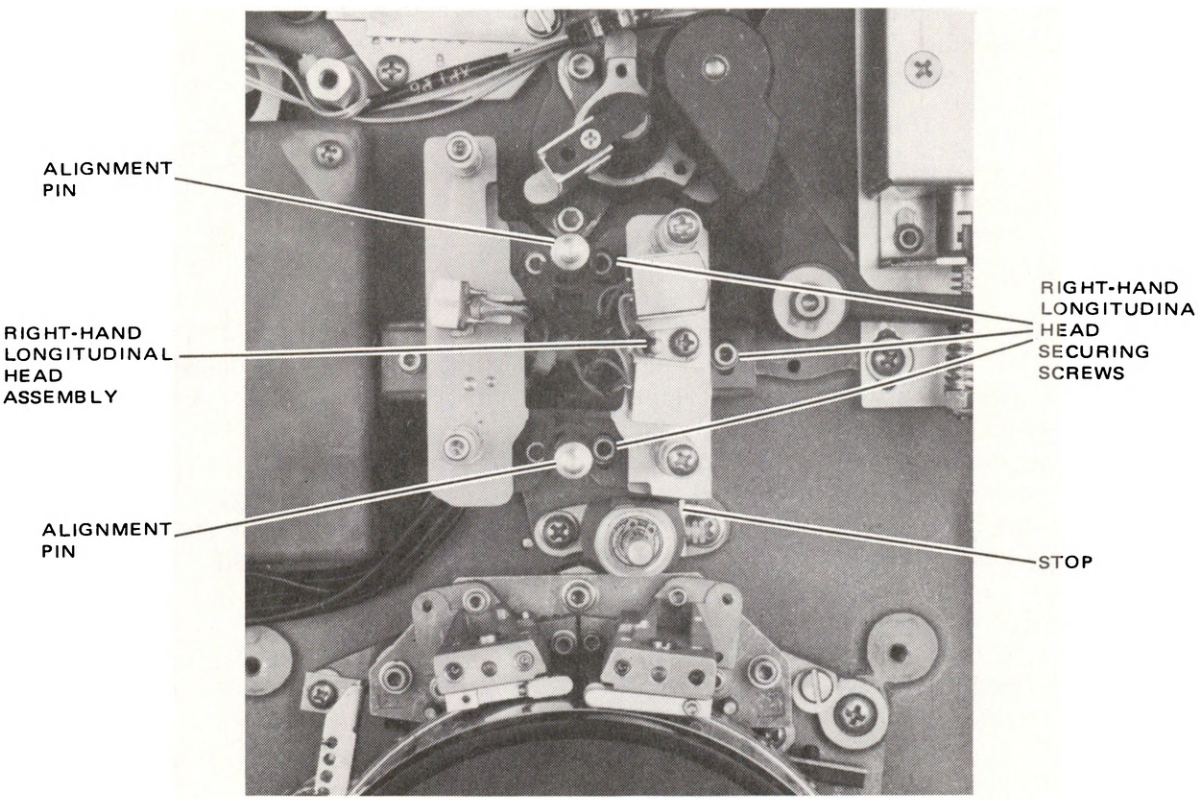


Figure 3-27. Longitudinal Head Assembly Securing Screws and Alignment Pins

within ±15.0 μs, as described in step 6. (Note: moving the head assembly toward the capstan causes the playback-demodulated video to appear early with respect to the E-E reference.)

e. Press the head assembly against both alignment pins (shown in Figure 3-26) and tighten the three securing screws.

8. Check results by repeating steps 4, 5, and 6, as required.

9. Press the stop against the head assembly and tighten the securing screw.

10. Reinstall transport trim and audio head cover.

3-46. Electrical Checks and Adjustments

The adjustment procedures that follow are to be performed after maintenance where components have been replaced or an entire PWA has been exchanged.

3-47. Initial Conditions. Before starting any alignment procedure, complete the following steps.

1. Make sure that all PWA's are firmly seated in their respective sockets.

2. Determine that the VPR is properly installed in a system and that the necessary input signals, adjusted to the correct level, are connected.

3. Turn power on and allow three minutes for temperature stabilization.

CAUTION

TO PREVENT POSSIBLE DAMAGE TO ELECTRICAL COMPONENTS. ALWAYS TURN VPR POWER OFF BEFORE REMOVING OR INSTALLING A PRINTED WIRING ASSEMBLY (PWA) INTO THE VPR.

3-48. Power Supply Check and Adjustment. Check and adjust the power supply and the power supply regulator PWA as follows:

1. With power off, place extender board into the PWA position 3 in the electronics assembly (extract EBU Audio PWA if present).

2. Connect a digital voltmeter to TP2 (+12 Vdc reference) and TP3 (ground reference) on the Power Supply Regulator PWA (Figures 3-28 and 3-29).

3. Apply power. Voltage should be +12 ±0.002 Vdc. If necessary, adjust R4 (12V REF ADJ) on the Regulator PWA for the voltage specified.

4. Use the digital voltmeter to check regulated voltages at the following test points on extender board (GND pin is referenced). Note that these voltages are not adjustable.

   a. +5V pin +5 ±0.015 Vdc

   b. +12V pin +12 ±0.025 Vdc

   c. −12V pin −12 ±0.130 Vdc

NOTE

In the event of supply failure, remove all PWA's and repair before proceeding.

5. Check the unregulated power supply as follows:

   a. Remove power from the VPR.

   b. Remove plexiglass shield and remove two screws from the left-hand side of the AST Driver PWA (Figure 3-28) which secures the PWA and swing the PWA to one side to gain access to the capacitors behind the PWA.

WARNING

USE CAUTION WHEN MAKING THE FOLLOWING VOLTAGE CHECKS AS 400 VDC IS PRESENT ON SOME EXPOSED COMPONENTS.

   c. Apply power and use a digital voltmeter to check the following voltages referenced to the chassis (ground). (Note: These voltages, as measured not under load, will read higher than normal.)

      (1) Power chassis capacitor C1 plus terminal: +12 ±3.0 Vdc.

      (2) Power chassis capacitor C7 plus terminal: +21 ±2.0 Vdc.

      (3) Power chassis capacitor C6. plus terminal: +26 ±3.0 Vdc.

      (4) Power chassis capacitor C2, plus terminal: +48 ±5.0 Vdc.

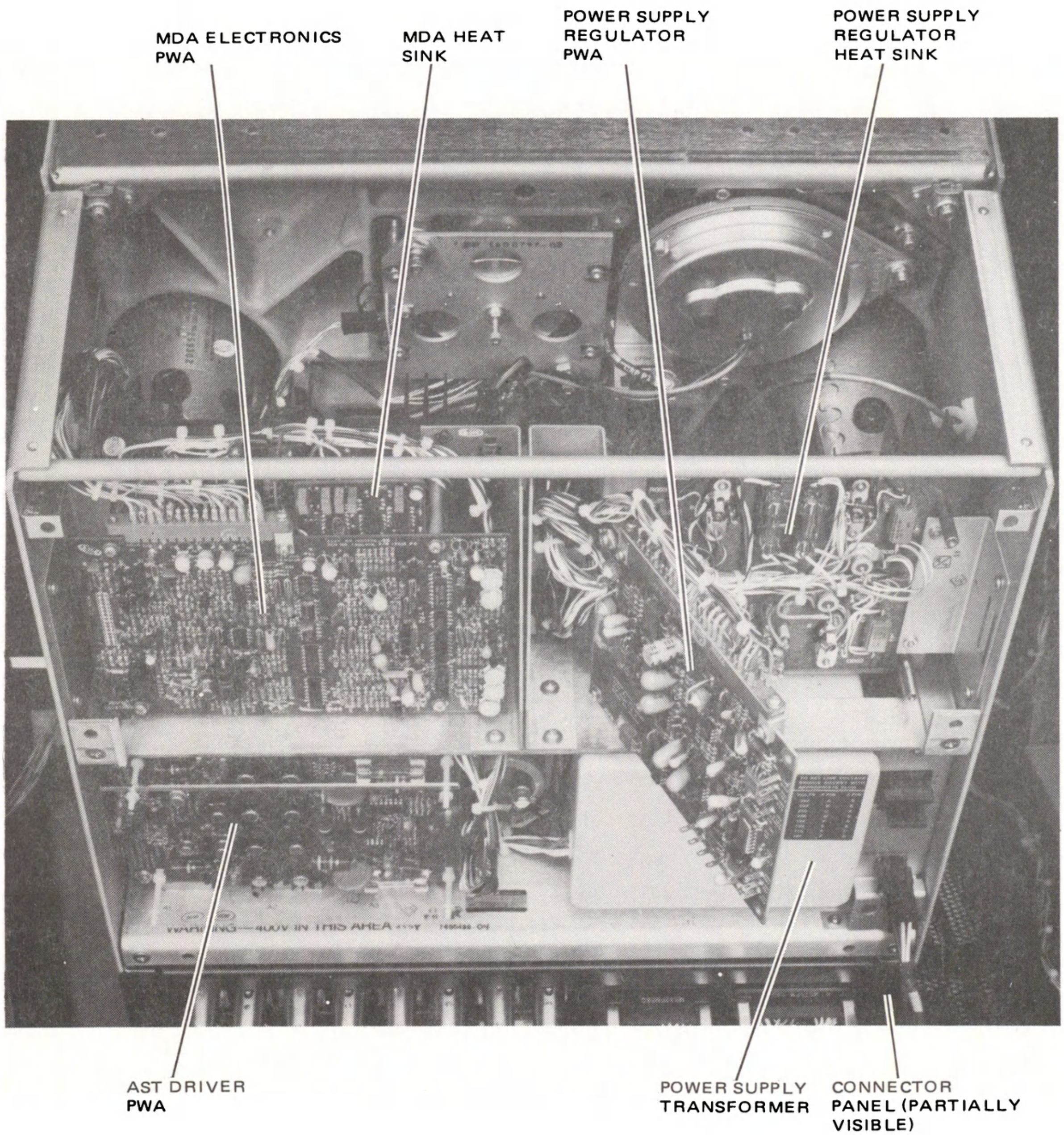


Figure 3-28. Rear View of VPR-2B with Covers Removed

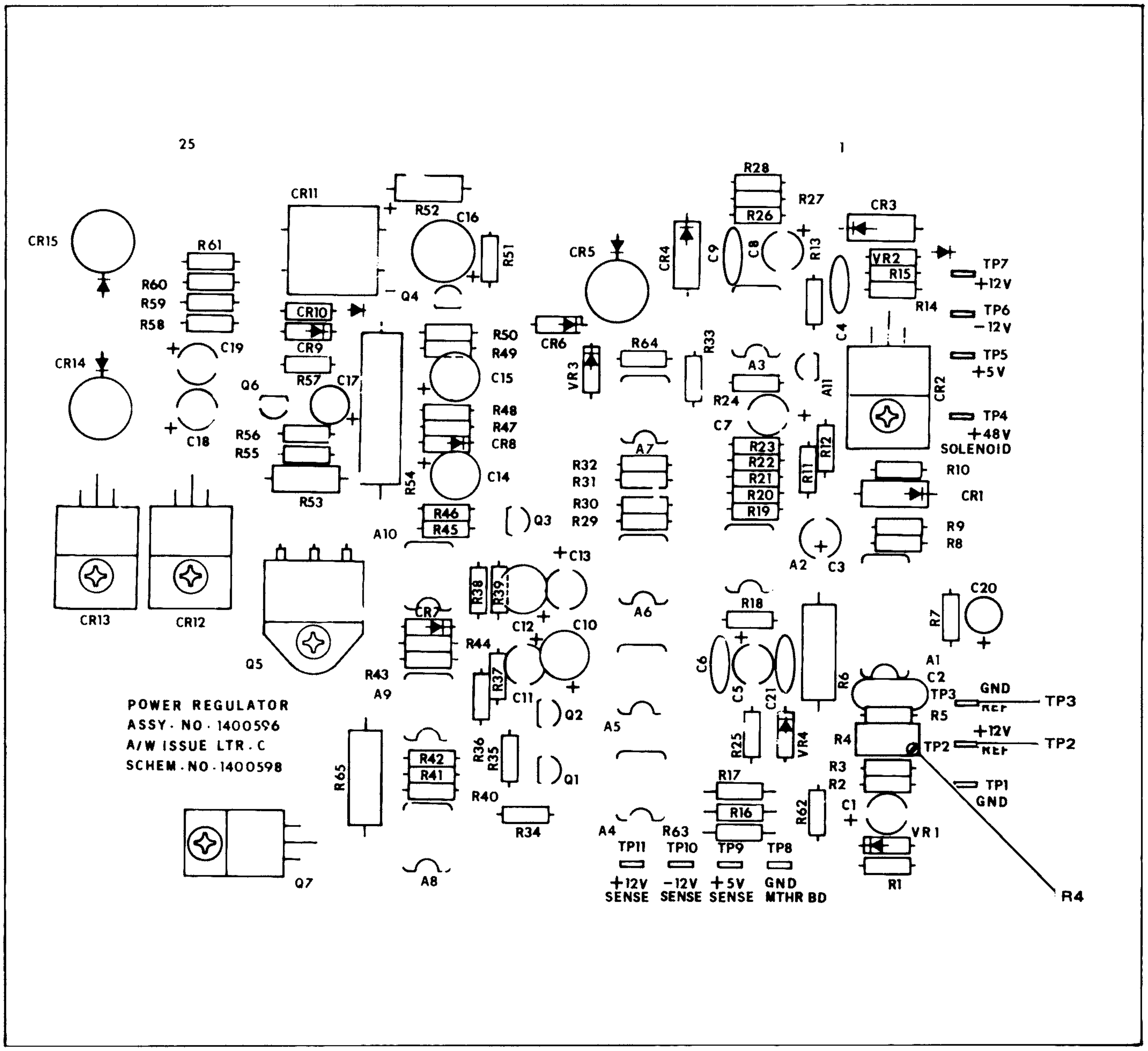


Figure 3-29. Power Supply Regulator PWA, Assembly No. 1400596

(5) Power chassis capacitor C3, minus terminal: −8 ± 2.0 Vdc.

(6) Power chassis capacitor C8, minus terminal: −21 ± 2.0 Vdc.

(7) Power chassis capacitor C5, minus terminal: −250 ± 10 Vdc.

(8) Power chassis capacitor C4, plus terminal: +250 ± 10 Vdc.

(9) Swing AST Driver PWA back in place to measure power chassis capacitor C9 plus terminal: +12 ± 2.0 Vdc.

6. Remove power and reinstall AST Driver PWA (Figure 3-30) (two screws), and plexiglass shield.

7. Remove extender board from electronics assembly. Replace EBU Audio PWA if removed earlier.

3-49. Tension Arm Photopotentiometer and Amplifier Check and Adjustment. Proceed as follows:

1. Connect scope probe to TP2 (tape tension) on MDA Electronics PWA (Figure 3-31).

2. Apply power to VPR with no tape threaded and tension arm in its rest position, scope should indicate −10 to −12 Vdc.

3. Remove idler cover. While moving tension arm slowly to the opposite position, observe on scope that voltage changes smoothly from −10 Vdc or −12 Vdc through zero volts to +10 to +12 Vdc without intermittent reversal of voltage polarity. When arm is released, tension arm should return to rest position and voltage should be −10 to −12 Vdc.

4. If when moving the tension arm toward either limit (step 3), and the voltage intermittently reverses its polarity by more than two volts, then adjust the position of either the tension arm board (assembly no. 1400676) or the light emitting diode board (assembly no. 1400677). These two boards have enlarged mounting holes that permit their position to be shifted slightly. Loosen the LED board mounting screws slightly to permit board position to be shifted (see Figure 3-32). After changing a board position, repeat steps 2 and 3.

3-50. Shuttle Mode Tape Speed Check and Adjustment. Check high speed shuttle (300 in/s) and the low speed shuttle (200 in/s) which occurs near the end of the reel as follows:

1. Connect scope probe to TP1 (tape tach) on the MDA Electronics PWA (Figure 5-31).

2. With power on, thread tape on transport and select full shuttle forward mode.

3. After tape is moving at the maximum speed, adjust R36 9MDA high speed control) for a pulse repetition rate of 220 μs (corresponds to 300 inches/sec). See Figure 3-33, waveform 1.

4. Select the full shuttle reverse mode.

5. After tape is moving at the maximum speed, check that the pulse repetition rate is also 220 ± 10 μs.

6. With power off, remove the Search PWA 18 and insert jumper 18J4 (from furnished parts kit) (Figure 3-34).

7. Replace Search PWA and turn power on and select full shuttle reverse mode.

8. Adjust R35 (MDA LOW SPEED) for a pulse repetition rate of 330 μs (200 inches/sec) (Figure 3-33 waveform 2).

9. Remove jumper 18J4 and select shuttle reverse mode.

10. Verify that as tape nears end of reel (about 1/16 inch), the shuttle speed decreased to 200 in/s.

3-51. Reference PWA 12 Adjustment and Playback Timing. Adjust reference PWA 12 and playback timing as follows:

1. With power off, remove Reference PWA 12 from the electronics assembly. Place the PWA on an extender board and reinstall into electronics assembly.

2. Verify that jumper 12J5 is in the proper position depending on machine configuration; position A–B 60 Hz, or position A–C 50 Hz (Figure 3-35).

3. Place editor select switch to the INSERT position.

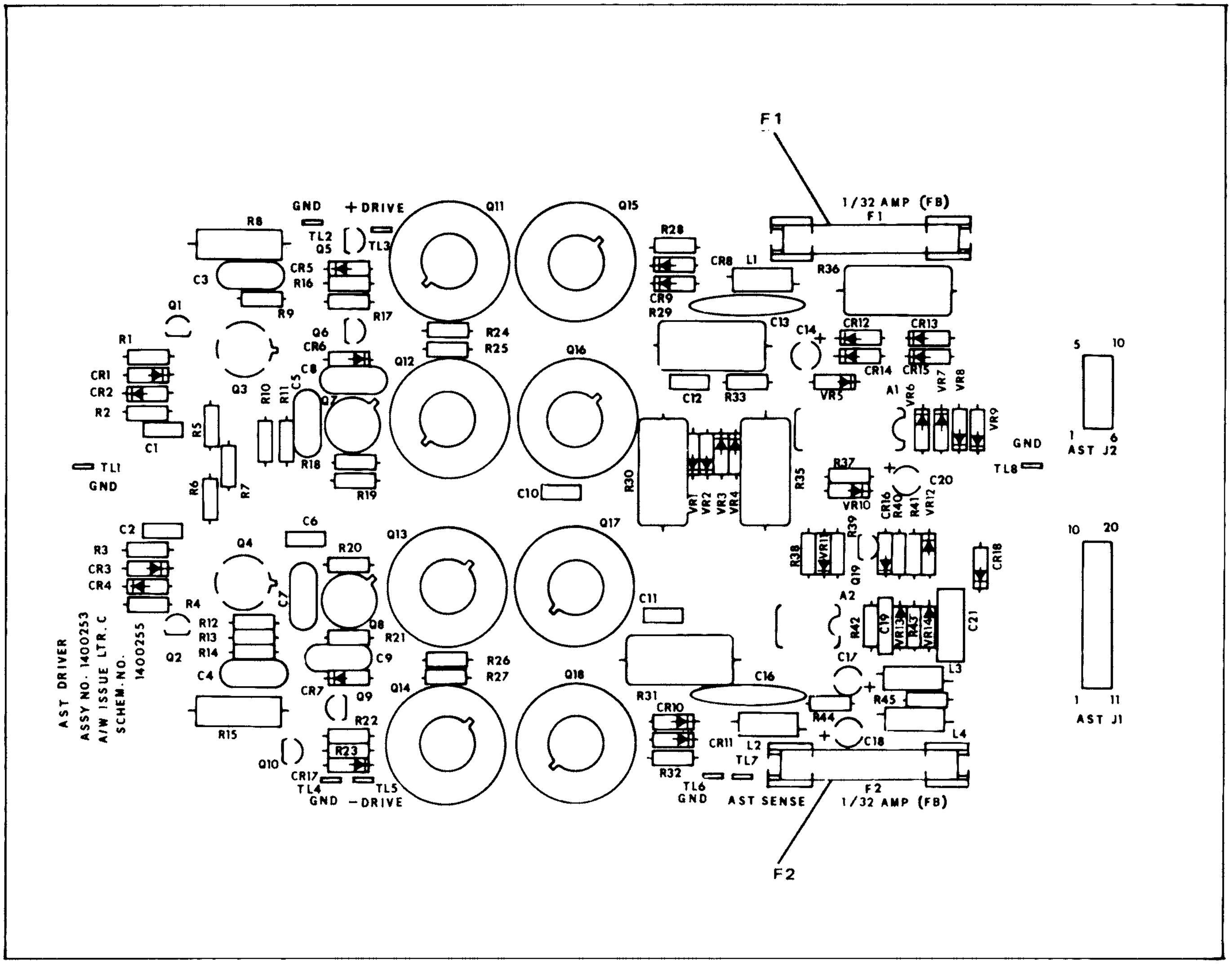


Figure 3-30. AST Driver PWA, Assembly No. 1400253

4. Apply power and check phase locked oscillator as follows:

   a. Connect scope probe to 12TP8 (oscillator error amplifier).

   b. Adjust 12L1 (error null) for stable dc presentation (indicates oscillator is locked) and continue to adjust for a dc level of 0V ±0.1 Vdc.

5. Connect scope probe to 12TP10 (vert ref) and trigger off the negative edge.

6. Set scope to display positive edge of vertical reference (10 μs/cm).

7. Remove reference cable from REF IN jack. Adjust video input level (variable) to minimum amplitude and verify that extinguished yellow SYSTEMS LED lights.

8. Verify that positive edge of signal moves less than 10 μs. If required, adjust 12L1 for minimum movement when switching video from unity to zero.

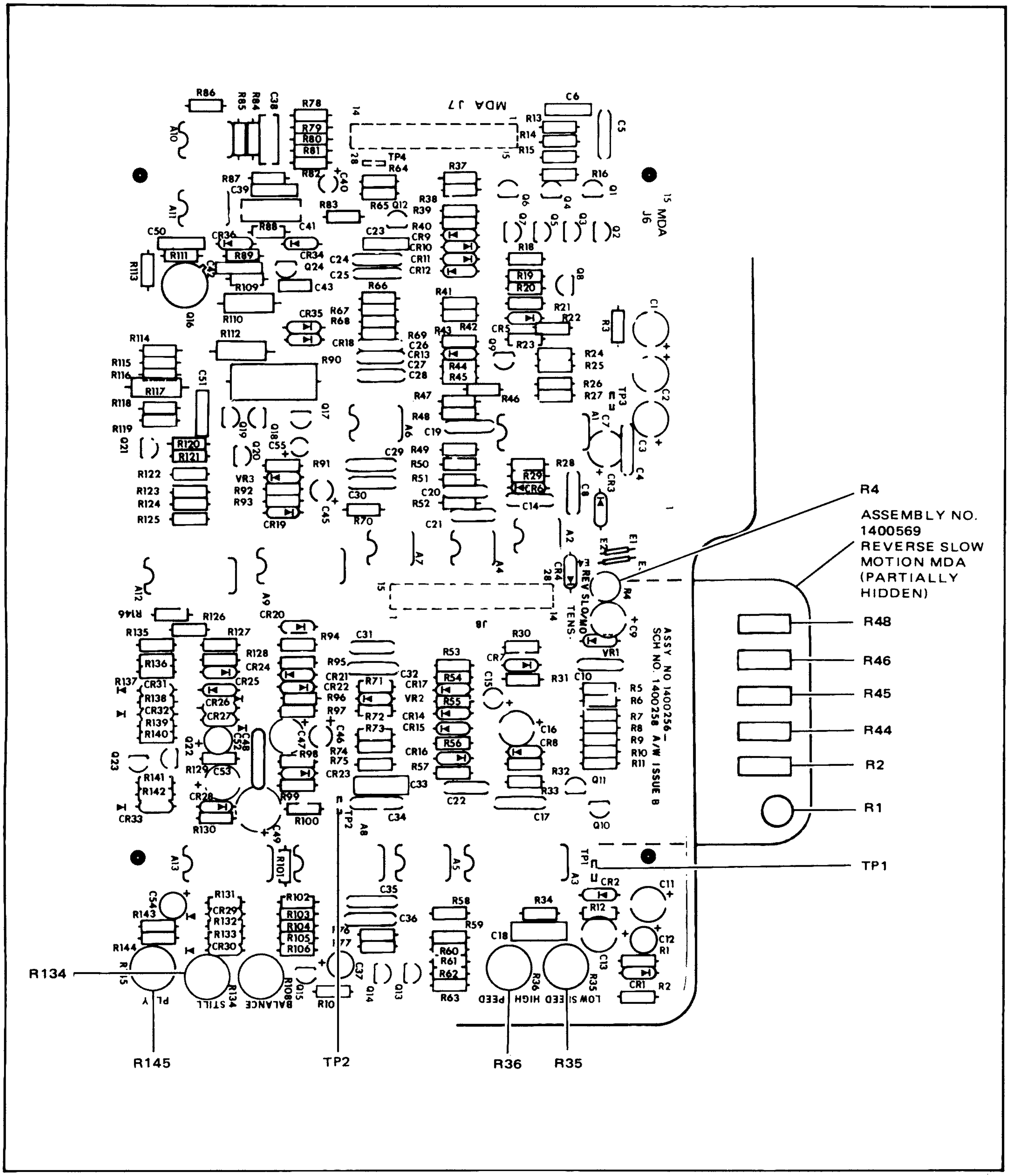


Figure 3-31. MDA Electronics, Assembly No. 1400256

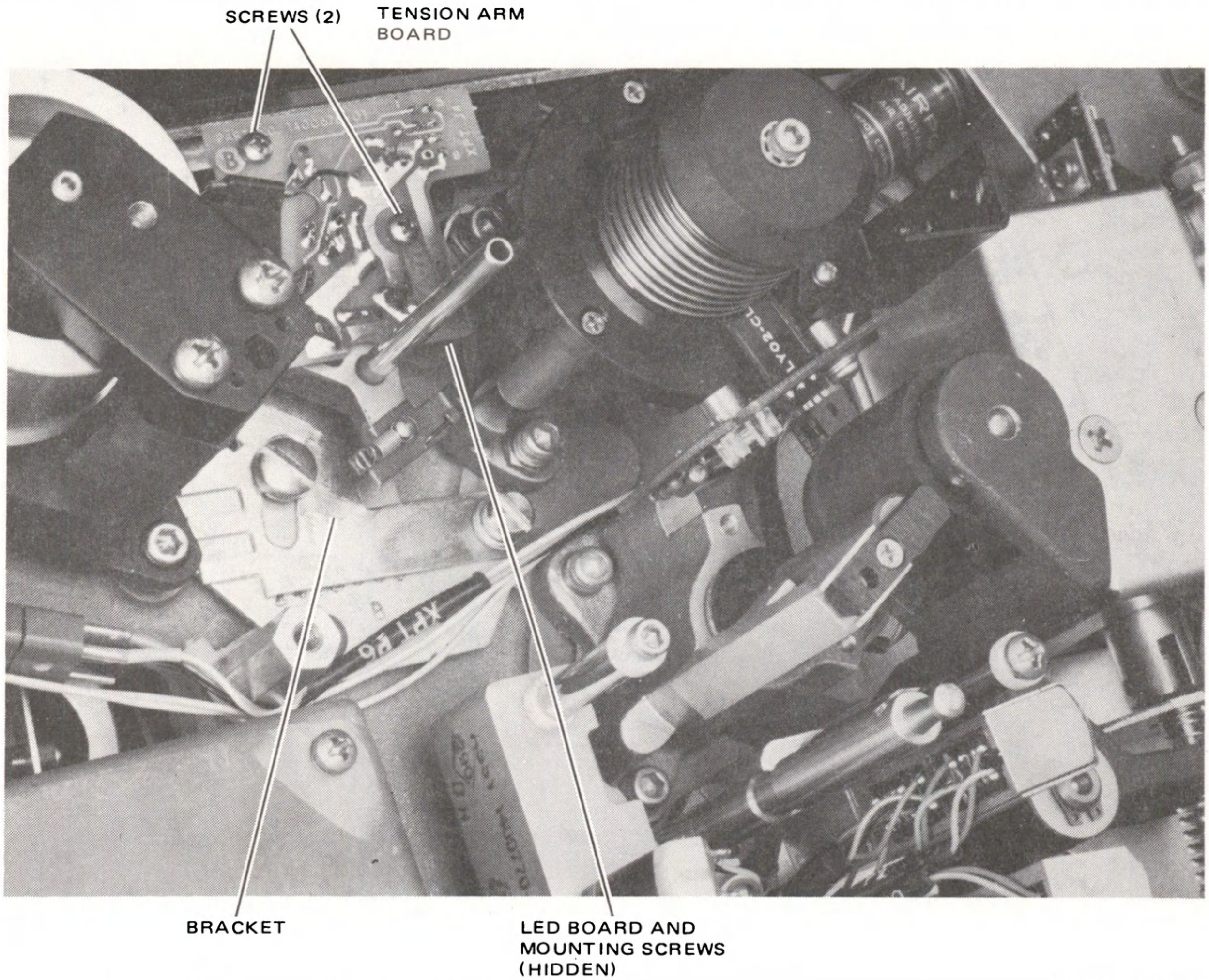


Figure 3-32. Tension Arm Photopotentiometer and Amplifier Check

9. Set TAPE/EE switch to EE with video input at unity. Reconnect reference cable to REF IN jack.

10. Connect channel 1 of scope to pins 51/52 (2H clock) and channel 2 to pins 19/20 (video in composite sync).

11. Trigger scope to channel 1 and alternate sweep at 5 μs/cm.

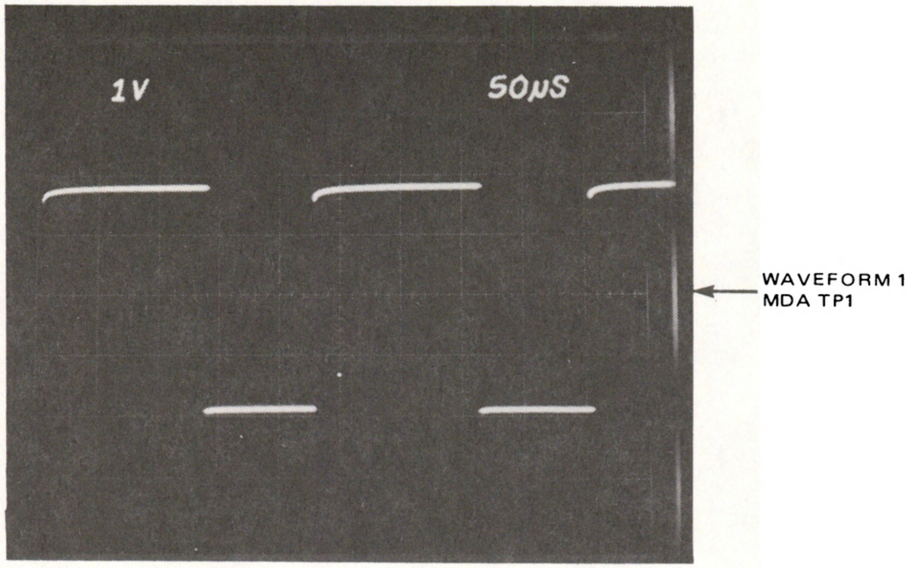
12. Expand leading edge of horizontal sync to 0.5 μs/cm (use sweep X 10 magnifier).

13. Adjust 12R20 (PHASE) until the positive transition on channel 1 is coincident with the leading edge of the video sync ±0.1 μs (see Figure 3-36, waveforms 1 and 2).

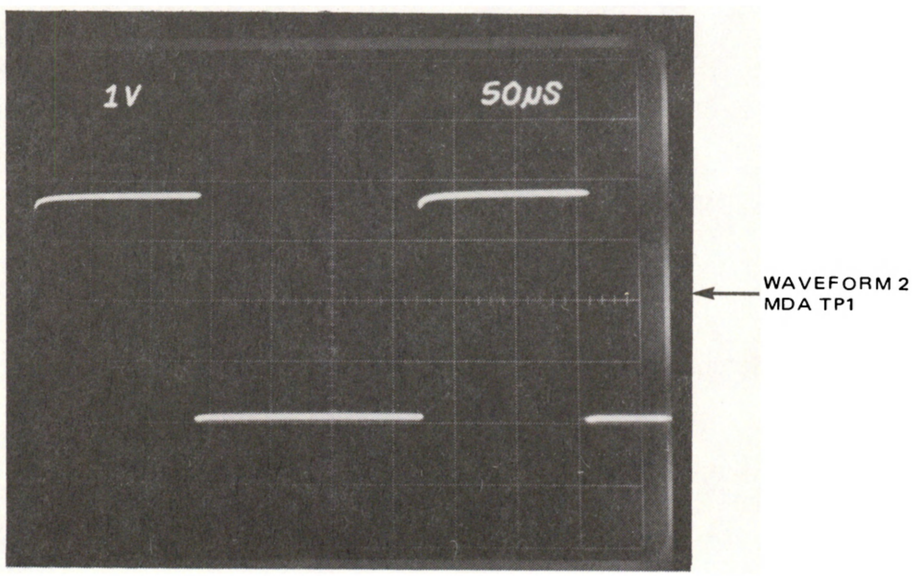
14. Connect channel 1 to PWA 12 pin 57 (scanner reference).

15. Expand scope to 100 μs/cm on video vertical sync.

16. Verify that positive edge of channel 1 pulse occurs at the second broad pulse. (Waveforms 3 and 4 respectively.)



MDA R36 CORRECT ADJUSTMENT



MDA R35 CORRECT ADJUSTMENT

Figure 3-33. Shuttle Mode Tape Speed Waveforms

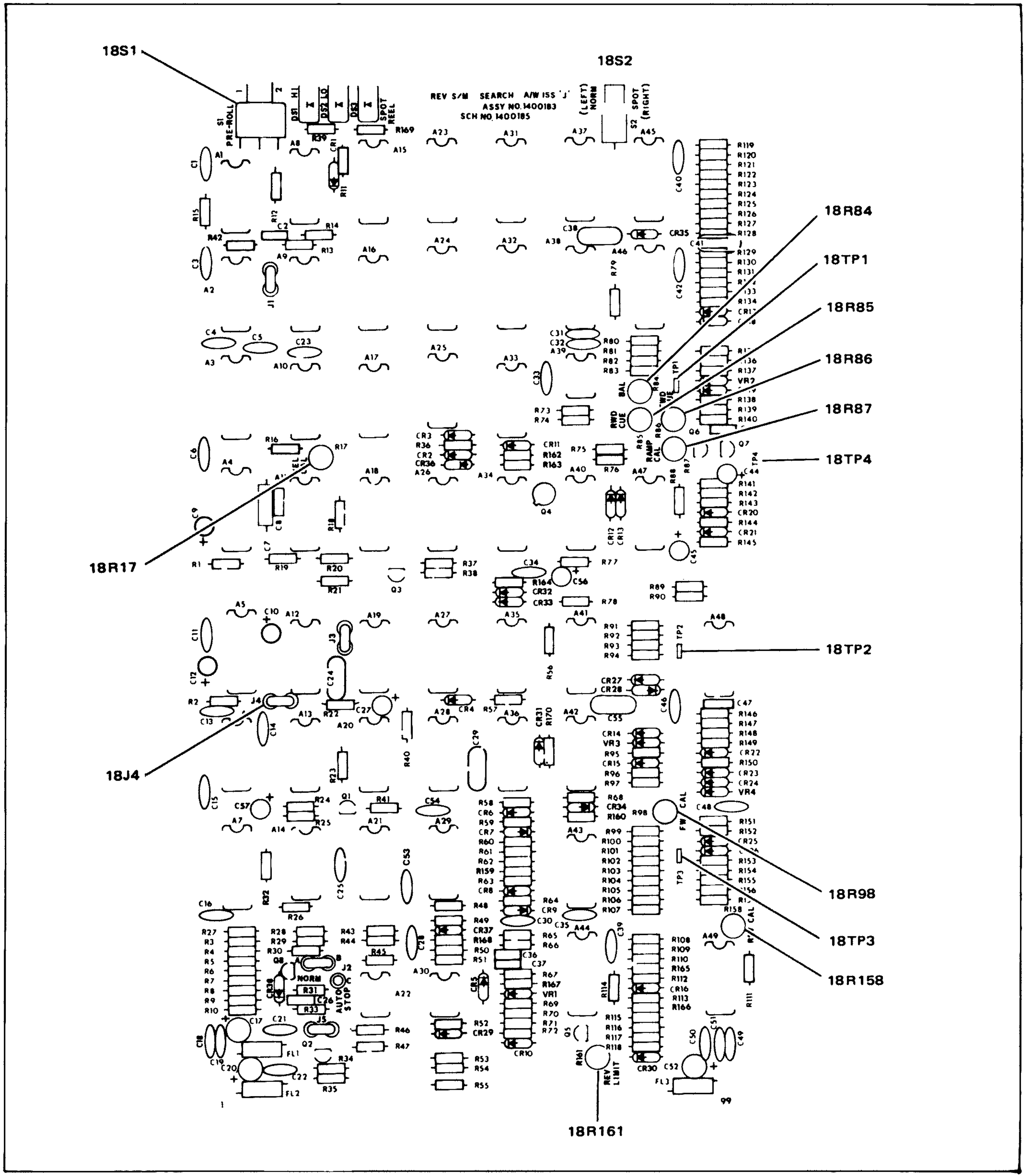


Figure 3-34. Search PWA 18, Assembly No. 1400183

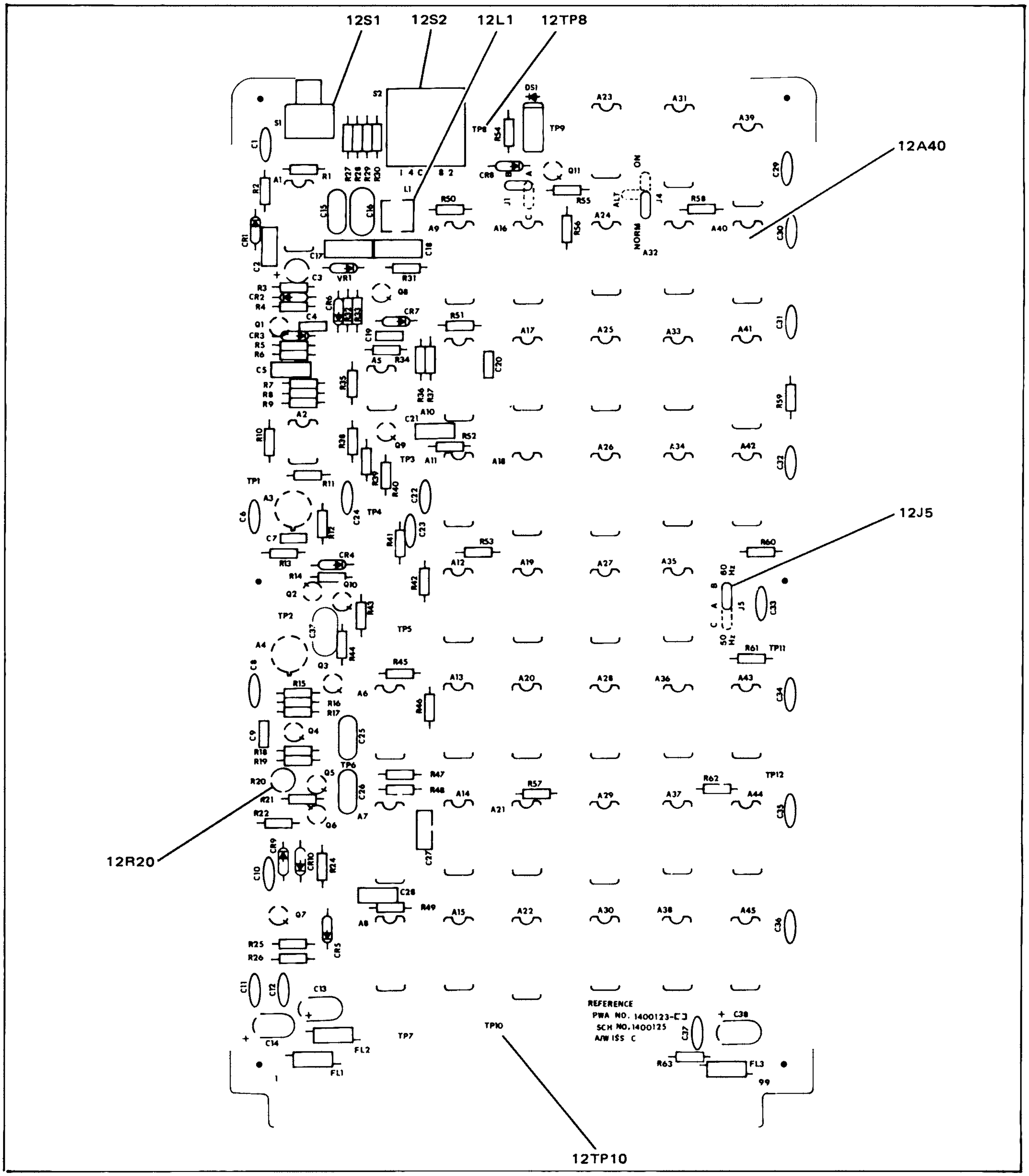


Figure 3-35. Reference PWA 12, Assembly No. 1400123

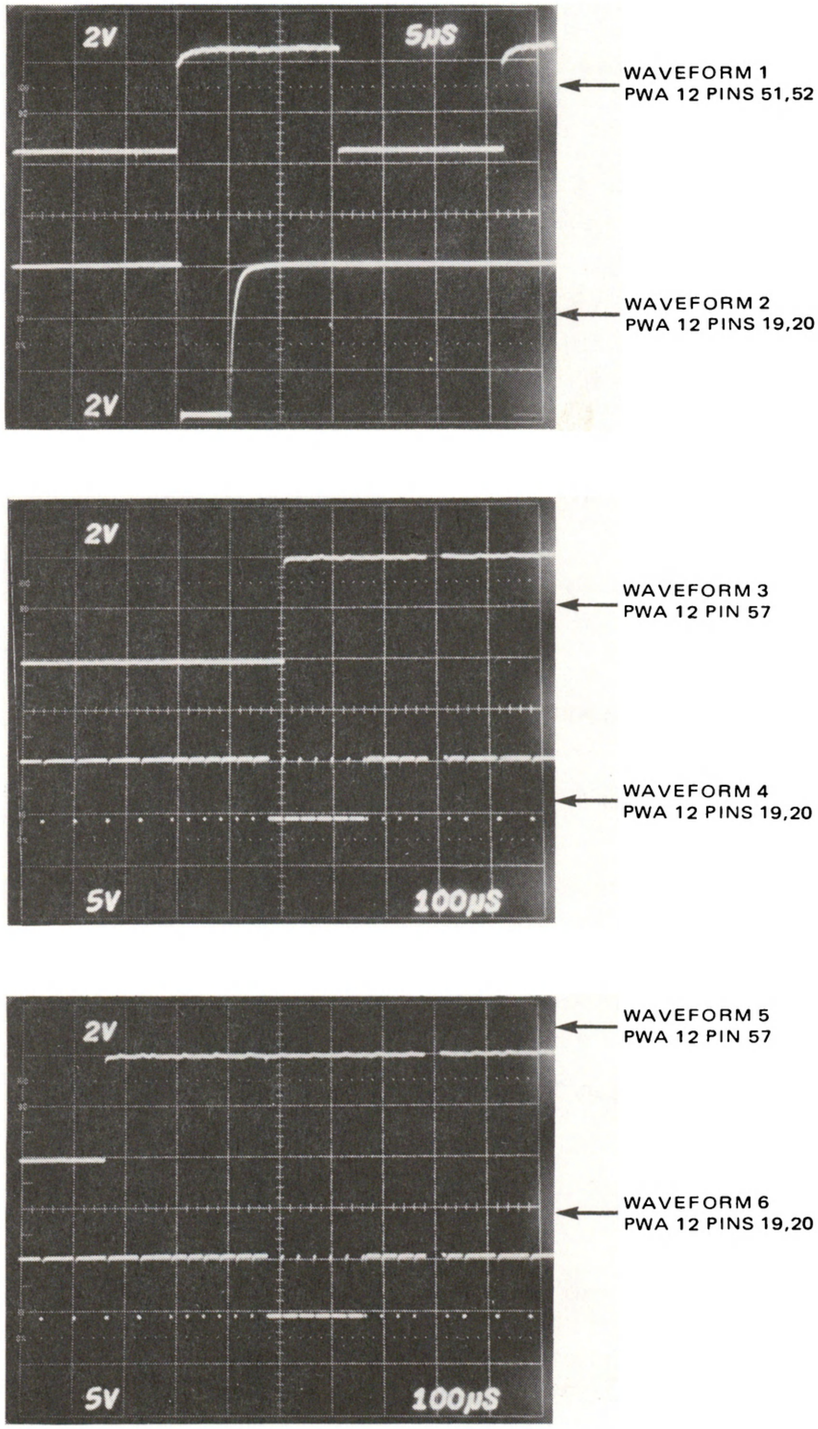


Figure 3-36. Reference PWA Adjustments

17. With playback TBC offset select thumbwheel switch 12S2 set to 13 (525 system only) set editor to NORMAL (off) and verify that signal at channel 1 moves up (earlier) by 6-1/2H (525 system) (waveforms 5 and 6). On a 625 system the thumbwheel switch is set to 3 and the TBC-2B supplies advance reference to the VTR.

18. Verify that signal jumps as the thumbwheel switch 12S2 is sequenced from 0 to 15. Reset thumbwheel to position 13.

NOTE

Normal setting of the playback TBC offset select thumbwheel switch is position 13 for a 525 system, and position 5 for a 625 system equipped with a one-line dropout compensator and position 7 for a 625 system equipped with a two-line dropout compensator.

19. Disconnect video from video input and REF IN input cables and verify that SYSTEM LED lights.

20. Connect video signal to VPR station reference and verify that SYSTEM LED goes out.

21. Select insert edit mode and verify that SYSTEM LED lights.

22. Connect video signal to video input.

23. Connect scope external trigger to vertical reference (Pins 55/56) and channel 2 to video input, pins 19/20.

24. Connect channel 1 to 12A40 pin 11 and set VPR to insert edit mode.

25. Depress READY switch and wait for scanner to lock.

26. Verify that the two positive pulses (on channel 1) occur with one pulse in the middle of the vertical sync region and the other pulse 1/3 field earlier. See Figure 3-37, waveforms 1 and 2.

27. Connect channel 1 to PWA 12 pin 91 (sync record gate) and set VTR in record mode.

28. Verify that negative TTL pulses occur during video vertical sync as shown in waveforms 3 and 4, Figure 3-37.

29. Turn video record enable off and verify that pulses disappear.

30. Connect channel 1 to PWA 12 pin 90 and observe a TTL high level.

31. Turn record enable on and verify that level goes low.

32. Remove power. Remove tape, left-hand idler cover and left-hand trim panel. Restore power. Set scope to 5V/cm and connect channel 1 to pin 1 of the erase oscillator PWA top connector and verify that a continuous rf signal exists (see Figure 3-38).

33. Turn video record enable off and on and verify that rf signal disappears and reappears and remains on.

34. Connect probe to pin 1 of erase oscillator output connector J3 (see Figure 3-38).

35. Verify that erase rf pulses occur 1/3 field before video vertical sync.

36. Turn video record enable off and select assembly mode.

37. Turn video record enable on and verify that erase pulses occur for two seconds and then disappear.

38. Remove power, remove extender board, and reinstall PWA's into electronics assembly. If stopping here, replace trim panel.

3-52. Scanner Servo PWA 11. Remove skins to expose parking brakes; remove capstan and idler covers. Proceed as follows:

1. With power off, remove Scanner Servo PWA 11 from the electronics assembly. Place the PWA on an extender board and reinstall into electronics assembly.

2. Trigger the scope from Reference PWA 12 pin 55/56. Select positive slope (Figure 3-35).

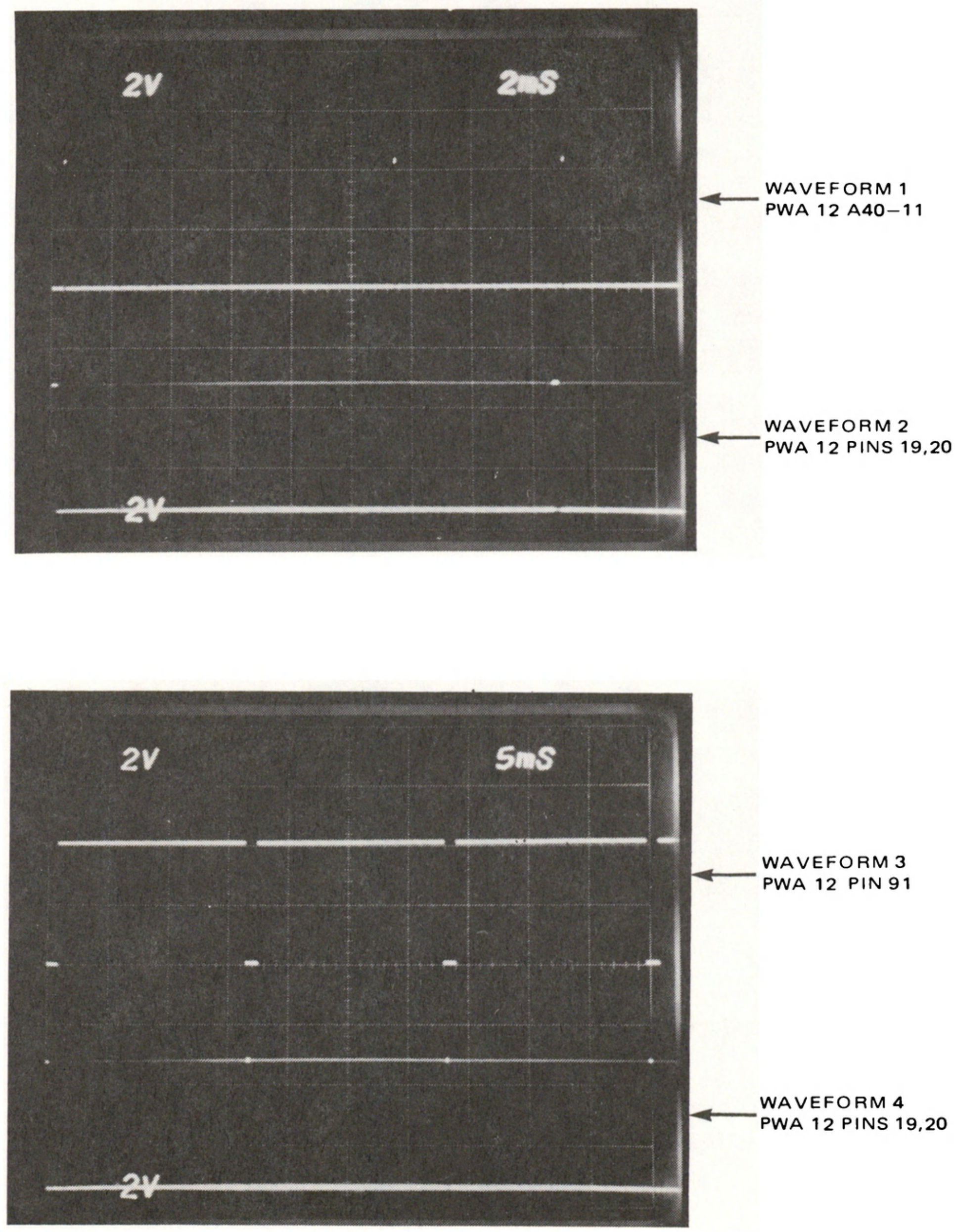


Figure 3-37. Reference Waveforms

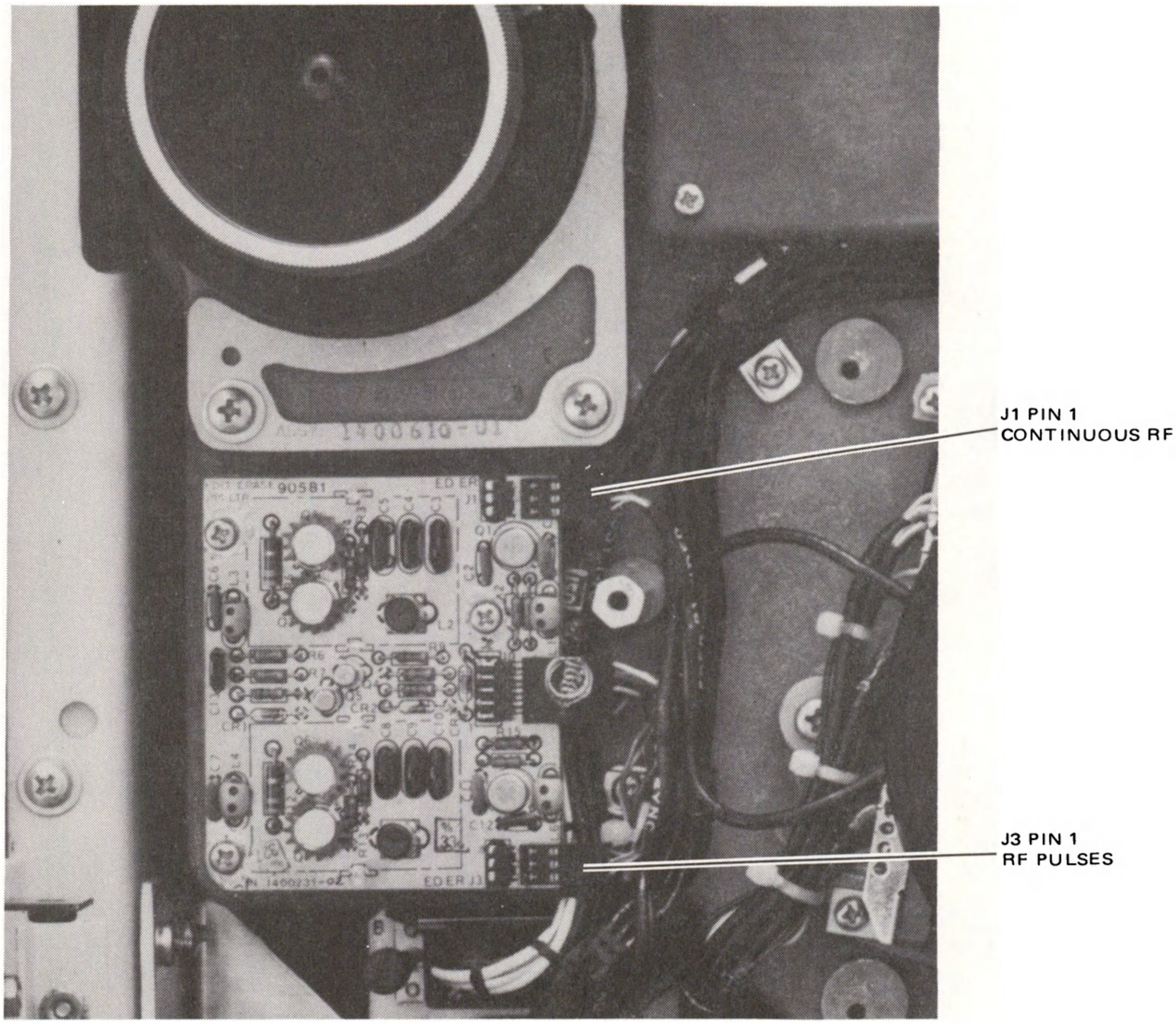


Figure 3-38. Edit Erase Oscillator PWA; Scope Probe Points for Reference PWA Procedure

3. Connect scope probe to 11TP4 (tach ref).

4. Apply power and observe the square wave at 11TP4.

5. Place edit select to INSERT and verify that square wave shifts to the right by approximately 6.0 ms.

6. Place edit select to OFF and verify that square wave returns to the original position as in step 4 above.

7. Use rubber bands to inhibit parking brakes and a Q-tip to block the end-of-tape sensor (see Figures 5-6, 5-7).

8. Press READY button, and verify that red SERVO LOCK light goes out in 5 to 8 seconds (indicates servo lockup).

9. If SERVO light does not go out, do the following:

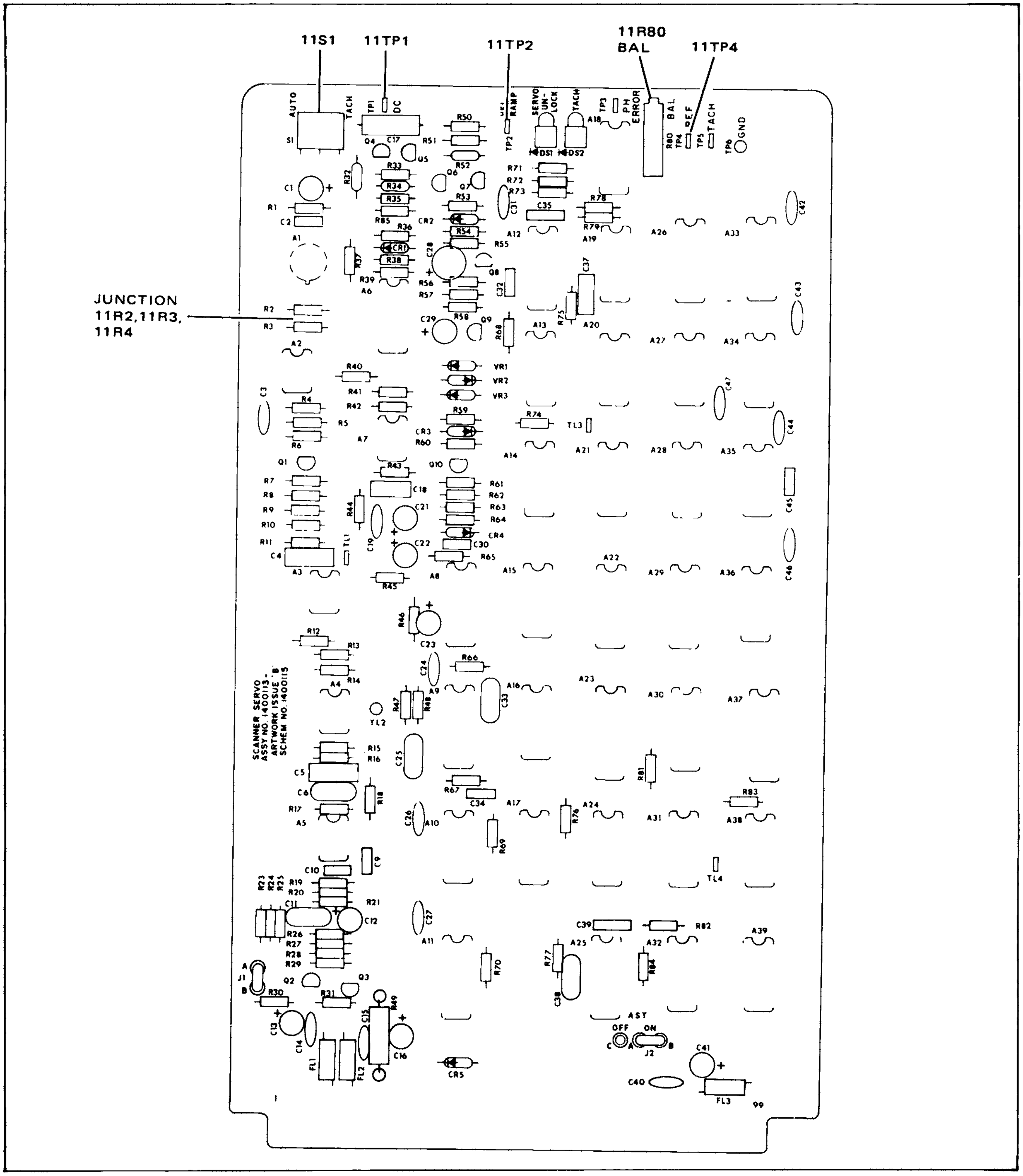


Figure 3-39. Scanner Servo PWA 11, Assembly No. 1400113

a. Jumper the junction of 11R2, 11R3, and 11R4 to ground.

b. Connect scope probe to 11TP2 (velocity ramp).

c. Adjust SERVO BALANCE ADJUST 11R80 until baseline about the narrow pulse is stationary (see Waveform, Figure 3-40).

d. Remove ground jumper and ensure SERVO LOCK light goes out (need not be 5 to 8 seconds); if so, repeat step 8 above.

e. If SERVO LOCK light does not go out, place scope probe at 11TP1 and adjust 11R80 for a dc level between +2.0V and +2.5V. Repeat step 8 above.

10. Remove power, remove extender board and reinstall PWA 11 into electronics assembly. Remove rubber bands, Q-Tip, and replace trim panels and cover.

3-53. Tape Timer PWA 19. Proceed as follows:

1. With power off, remove Tape Timer PWA 19 from the electronics assembly. Place the PWA on an extender board and reinstall into electronics assembly.

2. Connect scope probe 1 to pin 13 (phase 1) and scope probe 2 to pin 15 (phase 2) (Figure 3-41).

3. Apply power. While rotating tape timer idler by hand, verify a phase difference of approximately 90° exists between signals. Verify that there are no coincident leading or trailing edges.

NOTE

Failure of the VPR to satisfy step 3 is generally caused by a failure in the idler assembly.

4. Rotate tape timer idler by hand clockwise and verify that display counts up. Rotate tape timer idler counterclockwise and verify that display counts down.

5. Depress RESET switch so that display reads all zeros. Rotate timer idler counterclockwise one frame and verify timer reads 23:59:59:29.

6. Rotate timer idler clockwise until timer reads 00:00:59:29 and place switch 19S1 to the DF (drop frame) position (down).

7. Rotate the timer idler clockwise one frame; the timer now reads 00:01:00:02. Rotate the timer idler counterclockwise one frame and the timer now returns to 00:00:59:29.

8. Place switch 19S1 in the FF (up) (full frame) position. Rotate the timer idler clockwise one frame and the timer now reads 00:01:00:00.

9. Remove power, remove extender board, and reinstall PWA 19 into electronics assembly.

3-54. Search PWA 18. Refer to Figure 3-34 and proceed as follows:

1. With power off, remove Search PWA 18 from electronics assembly. Place PWA on an extender board and reinstall into electronics assembly.

2. Connect scope probe to pin 70 (tape tach).

3. Thread tape on transport, apply power, and place system into shuttle mode.

4. After tape is moving at the maximum speed in the forward direction, check that pulses at pin 70 have a pulse repetition rate of 220 μs (corresponds to 300 in/s). (see waveform 1, Figure 3-33). If pulse repetition rate is not as specified, perform the *Shuttle Mode Tape Speed Check and Adjustment* procedure, paragraph 3-50.

5. Connect scope probe to 18TP2 (velocity).

6. Select full shuttle forward mode and shuttle approximately five minutes play time of tape. While tape is moving at maximum speed,

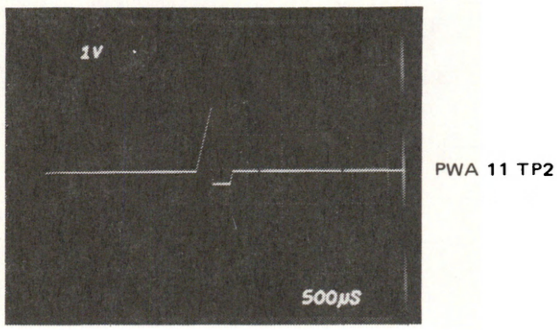


Figure 3-40. Scanner Servo Waveform

adjust 18R17 (celocity calibrate) for +3.0 Vec as read on scope.

7. Press STOP switch.

8. Connect scope probe to 18TP4 (ramp).

9. Adjust 18R87 (RAMP) for 5.0 Vp-p.

10. Set PRE-ROLL switch 18S1 (Search PWA) to off (middle). Connect scope probe to 18TP1 (distance).

11. Press RESET and ENTRANCE switches on main control panel.

12. Adjust 18R84 (OFFSET CAL) for 0 Vdc ± 50 mV.

13. Rotate the SHUTTLE knob to the STOP (detent) position and press SLOW switch. Verify voltage at PWA 18 pin 64 is approximately +5 Vdc.

14. Adjust the SHUTTLE knob clockwise until scope indicates +6.0 Vdc at pin 64. Adjust 18R98 (FWD CAL) until tape just starts to move forward. Reverse adjustment of 18R98 until tape just stops moving. Do not adjust 18R98 past this point.

15. Rotate SHUTTLE knob clockwise until scope displays +4.0 Vdc. Adjust 18R158 (REV CAL) until tape just begins to move in reverse direction. Reverse adjustment of 18R158 until the tape just stops.

NOTE

The following step requires monitoring a test point internal to the Capstan Servo PWA while adjusting a component internal to the Search PWA. To accomplish this task, both PWA's may be extended, or the test point may be mini-clipped and then the PWA (with test lead) returned to the electronics assembly.

16. Connect scope probe clip lead to Capstan. Servo PWA 15 TP4. Sync scope on internal positive. Press SLOW button and rotate SHUTTLE knob fully counterclockwise (full reverse). Observe scope and adjust Search PWA 18R161 for a square wave period of 2.2 ms. This adjustment establishes the maximum reverse speed limit in reverse slow motion. Remove scope clip lead.

NOTE

The square wave may have some jitter. Therefore, take an averaging reading.

17. Turn power on and verify Search PWA pin 17 (FAST WIND) is at TTL high during shuttle and reverse slow motion modes, and a TTL low during play and stop modes.

18. Verify Search PWA pin 27 (SLOT SHUTTLE SPEED COMD) is at TTL low in play and shuttle modes (unless tape is at end of takeup reel), and at TTL high in slow motion and stop modes.

19. Press READY button (still mode). Rotate takeup reel by hand in both directions. Verify that rotation (jog) requires same torque in both directions. Adjust MDA PWA R134 (MDA STILL) as required.

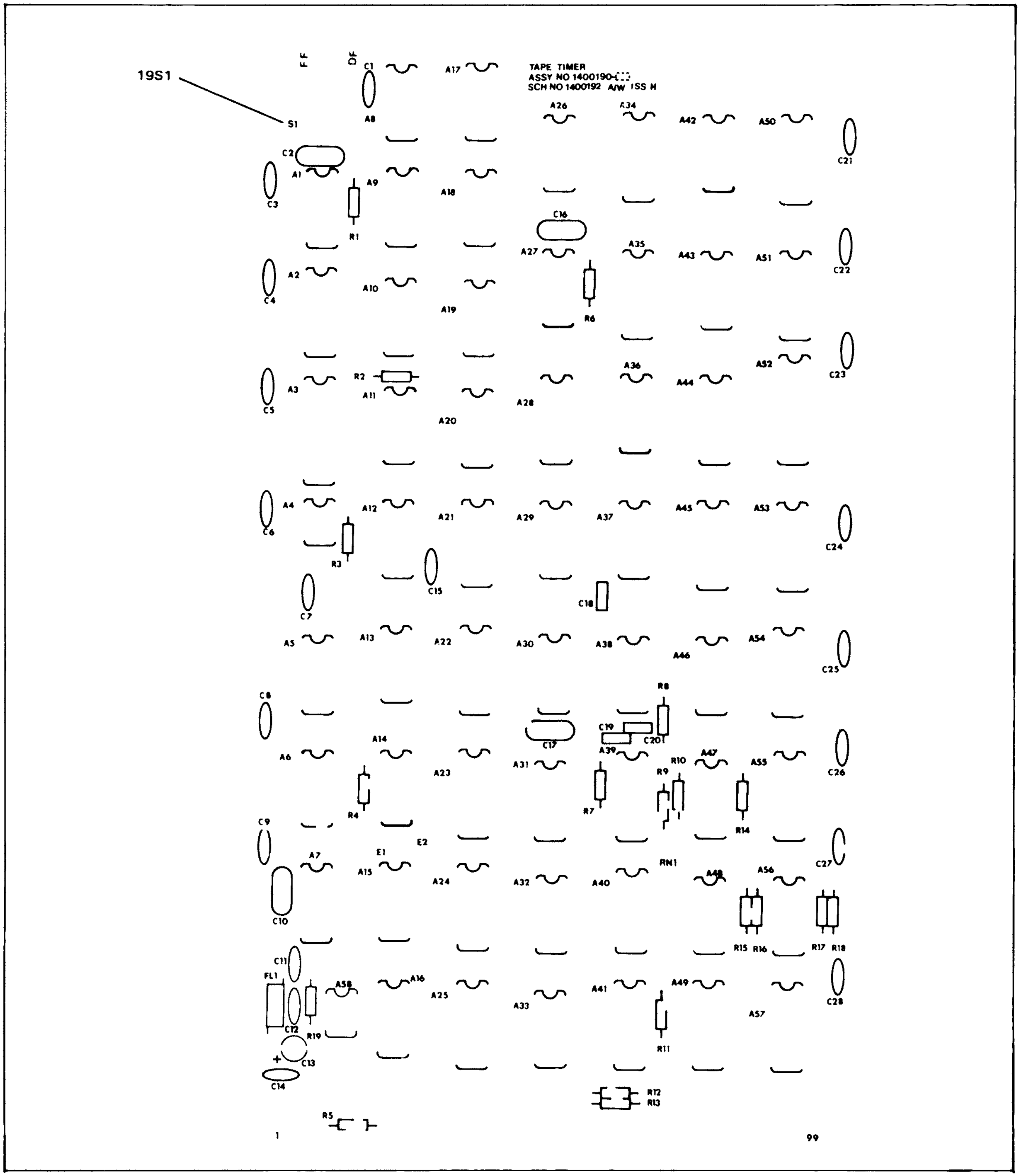


Figure 3-41. Tape Timer PWA 19, Assembly No. 1400190

20. Verify that STOP lamp flashes after 2.5 minutes of still frame. Verify that tape tension releases after an additional 30 seconds and STOP lamp stops flashing. Switch TAPE/EE switch to EE and back to TAPE and verify that tape tension is restored.

21. Press RESET button.

22. Place switch 18S1 to the PRE-ROLL 1 position (up).

23. Press ENTRANCE button.

24. While tape is in the rewind mode, press SEARCH button.

25. Verify that reels slow down and begin to move in the forward tape motion direction. The SEARCH lamp shall blink and the final approach speed to the cue point will occur without hunting or overshooting. Upon reaching the cue point, the timer shall read −5 seconds (−7 seconds for 50-Hz machines) ±1 frame. A zero frame error will cause the SEARCH LED to light continuously. In the event of error, perform the next step 26.

26. Select full shuttle rewind mode and shuttle five minutes play time of tape. Press SEARCH button. Adjust 18R86 (FWD) until final approach to the mark point occurs without hunting or overshooting. Repeat this step 26 until a smooth stop is achieved.

27. Select full shuttle forward mode and shuttle approximately five minutes play time of tape. While tape is moving in the forward direction, press SEARCH button. Verify that reels slow down and begin to move in the rewind direction. Verity that the final approach to the mark point occurs without hunting or overshooting. In the event of error, perform the next step 28.

28. Select full shuttle forward mode and shuttle approximately five minutes play time of tape. Press SEARCH button. Adjust 18R85 (RWD) until final approach to the mark occurs without hunting or overshooting. Repeat this step 28 until a smooth stop is achieved.

29. Place switch 18S1 in PRE-ROLL 2 position (down).

30. Repeat steps 24 and 25. Verify that the mark point is 33 frames rather than −5 seconds.

31. Place switch 18S1 (PRE-ROLL) in the OFF position.

32 Press RESET and ENTRANCE buttons.

33. Select rewind mode to shuttle approximately five minutes play time of tape. While tape is moving, press SEARCH button. Verify that when the mark point is reached, the tape timer reads 0 ±1 frame without the five-second preroll.

34. Place switch 18S1 to PRE-ROLL 1 position and repeat step 27.

35. Remove power, remove extender board, and reinstall PWA 18 (and PWA 15 if applicable) into the electronics assembly.

36. Place switch 18S2 (SPOT REEL) in the spot reel position and verify that the SYSTEMS indicator LED is on. Shuttle to the voltage at PWA 18 pin 28 (CS HALF SPEED) is negative.

37. Set switch 18S2 to NORMAL position and verify that the voltage at PWA 18 pin 28 is positive.

3-55. Motor Drive Amplifier (MDA) Reverse Mode Adjustments. The MDA incorporates a piggyback PWA, which mounts to the MDA above the component side. Adjustable components of the MDA piggyback are as follows (Figure 3-31):

R1 — Digital-to-analog (D/A) offset adjust. Corrects for any offset in the supply reel pack D/A Converter.

R2 — REV/PLAY tension delay (normal play mode). Controls the time constant or rate at which the supply reel tension servo changes from high tension in reverse to normal tension in play.

R44 — Reverse take up tension adjust. Control tape tension provided by the takeup reel system in the reverse mode.

R45 — Reverse supply tension correction. Affects supply tension servo system. Adjusted for constant supply tension as the tape pack transports to minimum tape pack in the reverse mode.

R46 — FWD/REV damping. Used to apply the correct amount of damping to the supply tension servo system to ensure proper servo transient response when tension is increased during reverse operation.

R48 — SLO REV/SLO FWD (not normal play) tension delay. Function is similar to that of R2 above. Controls the time constant or rate at which the supply reel tension servo changes from high tension in reverse slow motion to normal tension in forward slow motion. Separate controls are necessary because acceleration for Capstan Servo System differs between forward mode normal, forward mode variable, etc.

R37 — FWD/REV offset adjust. provides a variable offset to the supply tension circuit. Adjusted so that supply tension in stop mode is the same following reverse mode as it is following forward mode.

Align the reverse functions of the MDA using the procedure below:

1. Initial conditions. Set MDA piggyback controls as follows: R1, R2, R46, and R48 to full counterclockwise position — advance R48 (only) about 4 turns clockwise (from full counterclockwise); R45 to full clockwise position.

2. With a 90-minute roll of tape threaded on transport (tape pack not critical), press PLAY switch and adjust R108 (balance control) on the motor drive amplifier (MDA) so that the tension arm is in the center of its range (approximately over the tape tension adjust screw).

NOTE

In normal speed play mode the tension arm should *not* be in contact with the leaf spring on the idler base.

3. Rotate the SHUTTLE knob to STOP (detent) position and depress SLOW switch.

4. Slowly rotate takeup reel counterclockwise. The tension arm should move slightly to the left but not contact the reverse tension leaf spring on the idler base.

5. Rotate the SHUTTLE knob toward REF. The tension arm should come in contact with the reverse tension spring.

6. Press PLAY button and measure supply holdback tape tension with the Tentelometer placed between the scanner entrance guide and the longitudinal head assembly fixed guide. Tension should be 4.5 ounces (127 grams).

7. If tension is not 4.5 ounces, depress STOP button and slightly loosen the slotted screw. If tension is to be increased, push serrated plate upward. If tension is to be decreased, push plate downward. Tension should be 4.5 ounces (127 grams). Tighten slotted screw when adjustment is complete.

NOTE

Photocell on tension arm should be covered to prevent ambient light from affecting the adjustment.

8. With a maximum of 1/4-inch tape pack on the takeup reel, depress PLAY button.

NOTE

Ensure that the supply reel makes at least two revolutions after power is applied, before making the following adjustments.

9. Measure takeup tension with the Tentelometer placed between the timer idler and takeup reel.

10. Adjust R145 (play takeup tension adjust) on the MDA for a takeup tension reading of 15 ± 0.5 ounces (425 ± 14 grams).

11. Place system in reverse slow-motion mode.

12. Measure takeup tension with the Tentelometer placed between the timer idler reel and takeup reel.

13. Adjust R44 on MDA Piggyback for a takeup tension reading of 5.0 ounces (141 grams) at beginning of tape pack (90-minute reel).

NOTE

Ensure that the takeup pack is still less than 1/4 of the total tape pack.

14. Put system into the STOP mode. Adjust the R1 on MDA piggyback for a reading of 0V ± 250 mV @ TP1.

15. Place system into full reverse slow-motion mode. Adjust R4 on MDA for a tension of 8.0 oz at scanner input. Move Tentelometer to scanner output, verify that tension is greater than 3 oz. If not, either tape or scanner surface has too much friction. (Note: Search PWA SPOT/NORMAL switch (18S2) must be in NORMAL position.)

16. Set oscilloscope sensitivity at 200 mV/cm, and set time base at 50 ms/division. Set oscilloscope to trigger on a negative-going TTL transition at A1-12 (TP3) on the MDA. Connect oscilloscope probe to TP4 (across R14 on some earlier version MDA's which lack TP4).

17. Observe the oscilloscope and rotate the SHUTTLE knob from full clockwise to full counterclockwise. The oscilloscope should trigger when the transport reverses direction.

18. Observe oscilloscope for a waveform typified by Figure 3-38 – R46 full counterclodkwise (top).

NOTE

If the RF envelope is being observed, notice that there may be a loss of head-to-tape contact during this transition.

RF will break up most noticeable at the beginning of the scan.

19. Rotate R46 on the MDA piggyback clockwise until the waveform compares favorable with the central waveform of Figure 3-42 (R46 correctly adjusted). Note that now the rf envelope has only minor amplitude disturbances during the forward-to-reverse transition.

NOTE

If R46 is rotated too far clockwise, a waveform typified by the bottom waveform of Figure 3-42 (R46) overcorrected) will result.

20. Shuttle tape until the take-up reel is nearly full (about 1 hour 20 minutes into pack). Place system in STOP mode.

21. Set scope at 1V/division. Place probe on TP2 of Piggyback, set scope trigger to auto or line. Manually rotate TU reel forward about 1/4 rev. Note voltage @ TP2. Rotate TU reel backwards about 1/4 rev then stop (be careful to not accidentally move tape forward after stopping). Adjust R37 on Piggyback MDA for the same voltage @ TP2 which was observed when tape was stopped coming from the forward direction.

22. Place system into FULL REVERSE SLO/MO. Monitor the tension at scanner input. Rotate R45 on MDA Piggyback counterclockwise until a reading of 8 oz. is observed.

23. While still in the REVERSE mode, measure the take-up tension between the timer idler and TU reel. It should be 5-to-7 oz.

24. Rewind tape until supply and take-up packs are About equal (45 minutes). Place system into FULL REVERSE SLO/MO. Verify that tape tension at scanner input is 8 oz ± 1 oz. If not, repeat steps 14 and 22.

25. Rewind tape until there is less than 1/4-inch of tape on the take-up reel.

26. Switch the VTR from FULL SLO REVERSE to SLO PLAY mode. Observe the RF envelope. It will collapse when going into PLAY mode, adjust R2 on Piggyback clockwise until leading edge of the RF envelope no longer drops in amplitude when going into PLAY from FULL REVERSE to PLAY.

NOTE

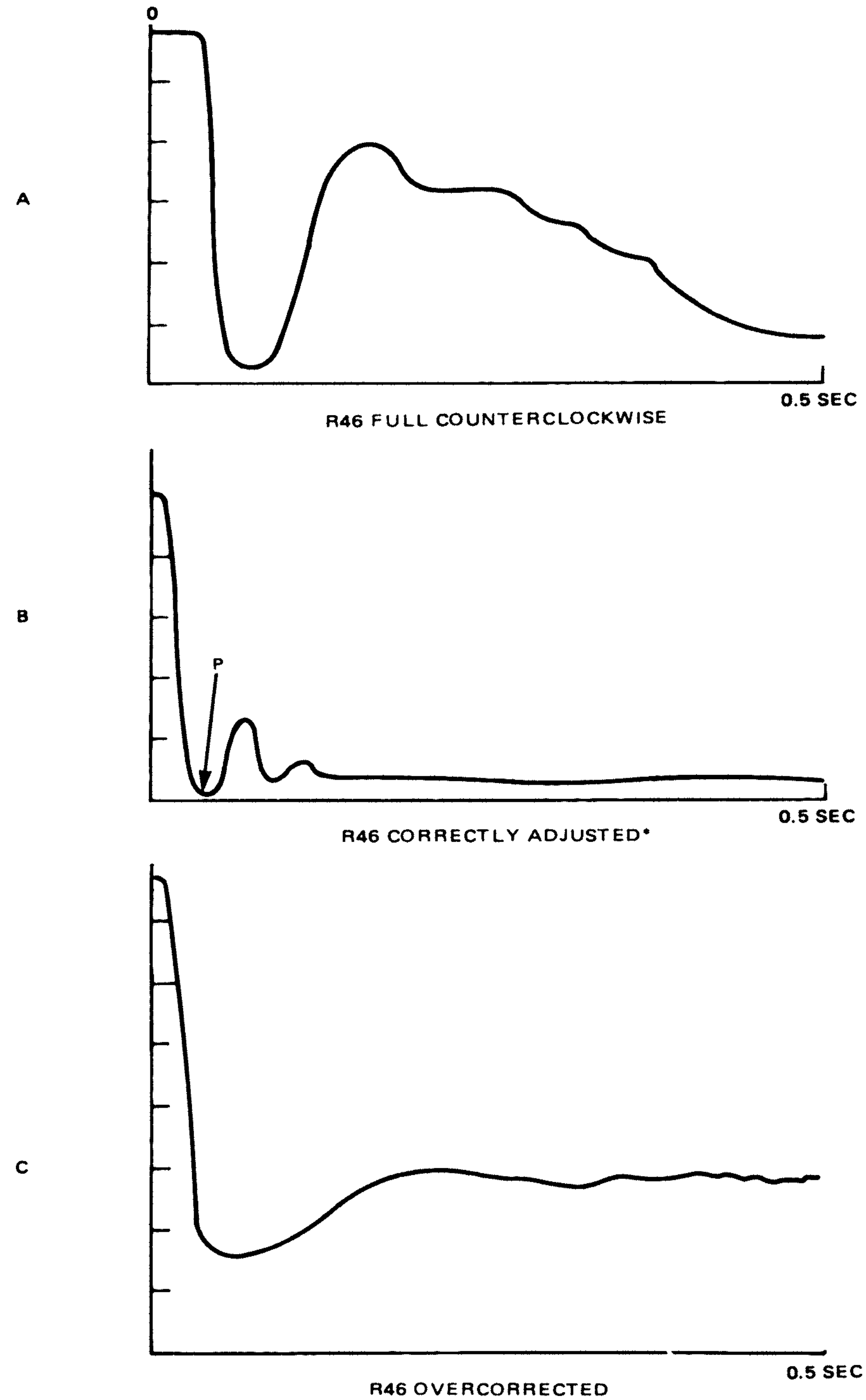
Some residual amplitude disturbances will always remain. The proper adjustment of R2 is where the first few lines of video after dropout are consistently noise-free during this transition — increasing R2 in the clockwise direction significantly beyond this point will continue to produce good RF performance. Peak tensions, however, will start to build up which will result in sync head erasure and capstan burnishing problems.

27. Repeat step 26 but going from SLO REVERSE to SLO FORWARD in the variable mode and adjusting R48 instead of R2. For fastest SLO-FWD-to-SLO-REV transitions, use an SMC-100 or equivalent (rather than quickly rotating the shuttle knob back and forth).

28. Check for sync erasure during various mode transitions both at the beginning and end of tape.

3-56. Color Framer PWA 13, NTSC. Proceed as follows:

1. With power off, remove Color Framer PWA 13 from the electronics assembly. Place the PWA on an extender board and reinstall into electronics assembly.
2. Remove video input and connect a standard NTSC color video signal to station REF input.



*Note: The "P" in the central waveform identifies correct adjustment for R46. The peak negative excursion of the waveform (point "P") is about equal to the steady-state value (after 0.5 second).

Figure 3-42. Waveforms Observed at MDA – R14 (TP4)

3. Place Reference PWA switch 12S1 (AUTO/REF/VIDEO) to the AUTO position (up) and apply power.

4. Connect scope probe 1 to PWA 13 pins 13/14 (ref video in) and scope probe 2 to pins 85/86 (7.8 kHz ref out) (Figure 3-43).

5. Negative trigger on probe 2 at 20 μs/cm.

6. Observe that square wave at 1/2 H-sync rate is present and expand sweep to display color burst during the negative portion of the 7.8-kHz signal (see Waveforms 2 and 1 respectively, Figure 3-44).

7. Adjust 13R1 (REF STD CAL) until STD PHASE (green) light on front of PWA illuminates and verify that first cycle of burst signal at over 50% amplitude is positive (Waveform 3, Figure 3-44.) If signal is incorrect, complete next step 8.

8. Continue to adjust 13R1 (REF STD CAL) until light goes off and then back on. This will reverse the video burst phase. Continue to adjust 13R1 to find the range in which the light remains lit. Set 13R1 to midrange.

9. Remove video signal from station REF input and connect to VIDEO IN.

10. Connect scope probe 1 to PWA 13 pins 19/20.

11. Repeat steps 6 through 8, adjust 13R74 (VIDEO STD CAL) in place of 13R1.

12. Place switch 13S1 (COLOR FRAMER) to ON (up) position and switch 13S2 (COLOR FRAME PHASE) to NORMAL (up) position.

13. With power off, remove PWA 13 and extender board from electronics assembly and reinstall PWA 13 into electronics assembly. Restore station REF input cable to VPR STATION REF input jack.

3-57. Color Framer PWA 13, PAL/SECAM. Proceed as follows:

1. With power off, remove Color Framer PWA 13 from the electronics assembly. Place the PWA on an extender board and reinstall into electronics assembly.

2. For PWA versions which have jumper J4, connect jumper 13J4 to the A–C position (Figure 3-45) (if J4 is absent, disregard). Remove video input, and connect a PAL or PAL-M color composite signal to the VPR REF input.

3. Place switch 12S1 (AUTO/REF/VIDEO) to the AUTO position and apply power.

4. Connect scope probe 1 to 13TP2 (PAL phase-locked oscillator), and trigger scope off scope probe 2 at pins 53/54 (H ref).

5. Adjust 13C16 (PAL phase-locked oscillator) for a continous string of pulses at a 7.8-kHz rate.

6. Scope probe 2 to 14TP4 (Control Track PWA) (probe 2 not viewed).

7. Adjust 13R1 so that the flag pulse occurs during field 1 of the 8-field sequence, and the green LED on PWA 13 is on.

8. Adjust 13R1 to the center of this range where the LED is on.

9. Move the video signal from station ref to video input and repeat step 8 but adjust 13R87 instead of 13R1.

10. Put Color Frame PWA back into VTR and set 13S1 to ON (up), and 13S2 to NORMAL (up).

3-58. Color Framer PWA 13, SECAM. Proceed as follows:

NOTE

The SECAM system does not have color framing, and therefore the LED indication and position of switch 13S1 (OFF/EDIT/ON), switch 13S2 (PHASE NORM/INV), and jumper 13J2 (NORMAL/RECORD) does not apply.

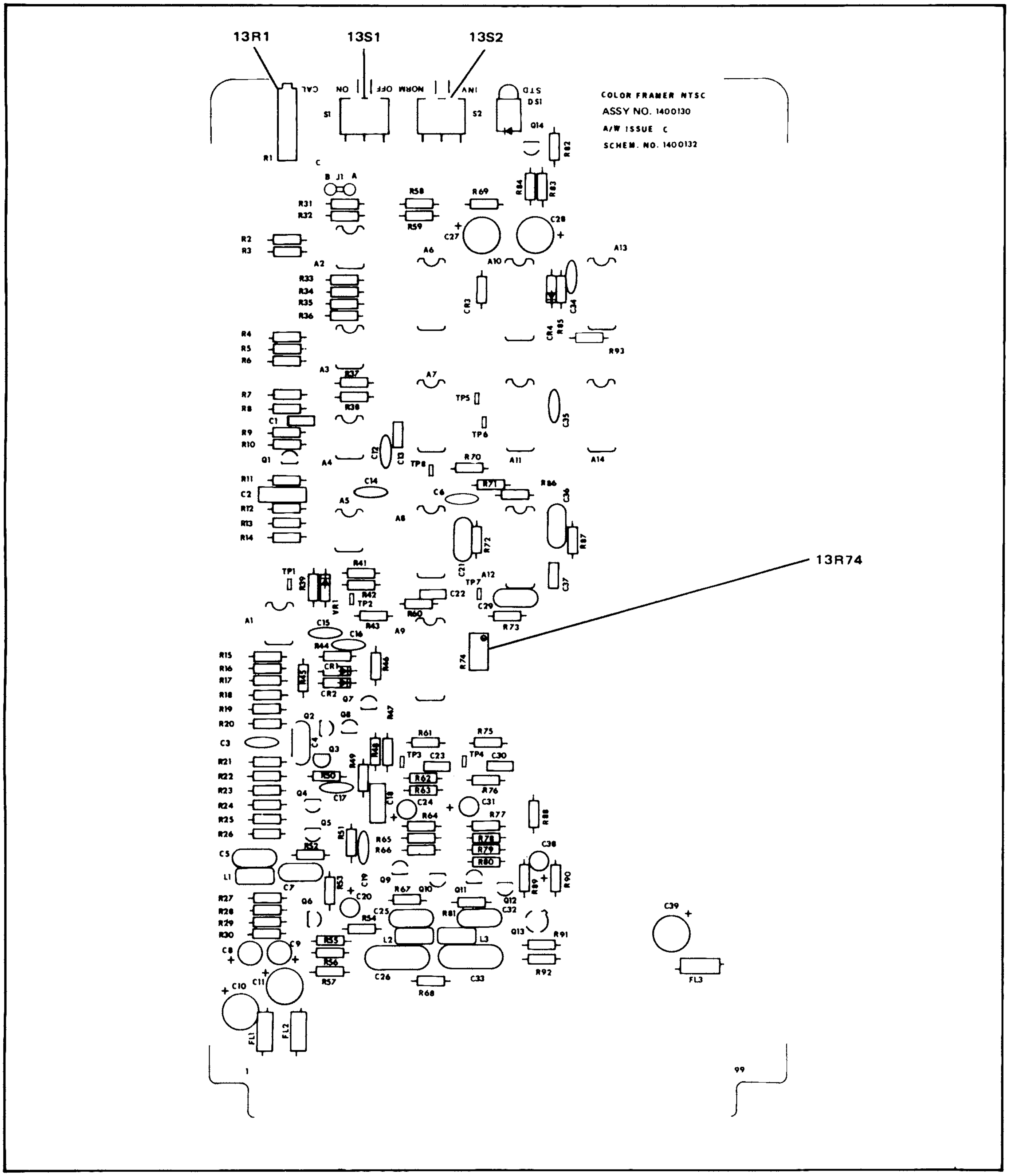


Figure 3-43. NTSC 525 Color Framer PWA 13, Assembly No. 1400130

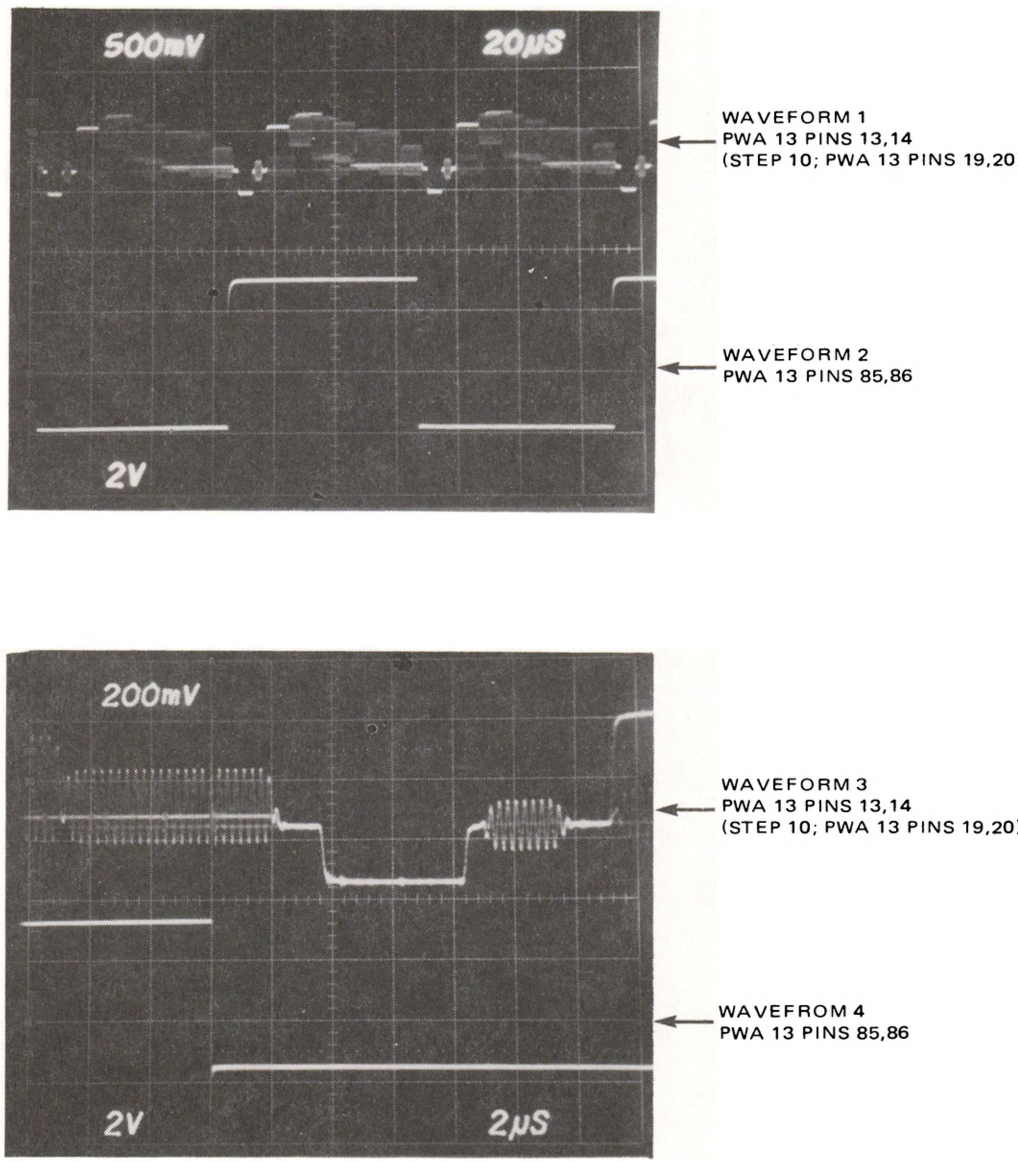


Figure 3-44. Color Framer NTSC Waveforms

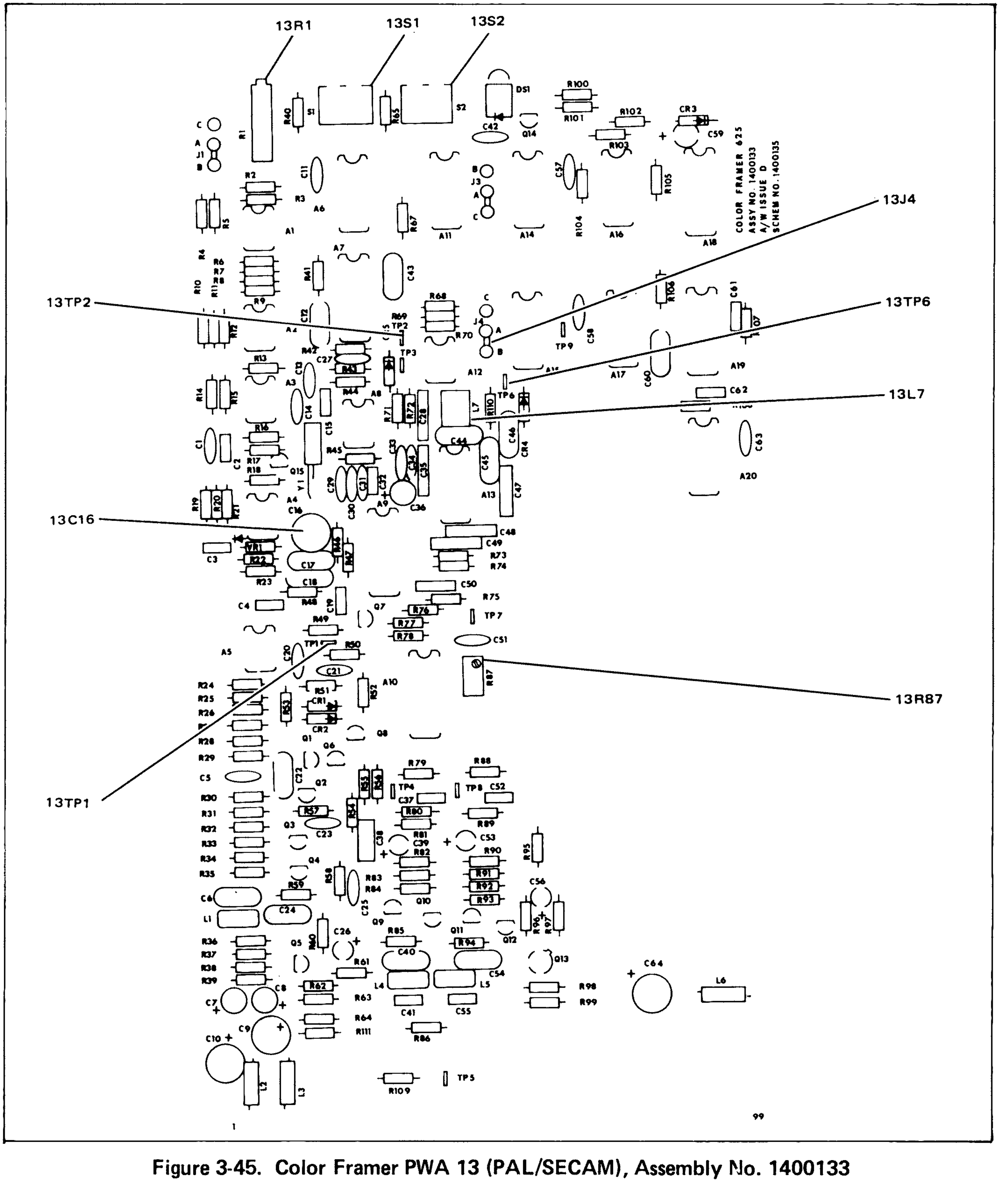


Figure 3-45. Color Framer PWA 13 (PAL/SECAM), Assembly No. 1400133

1. With power off, remove Color Framer PWA 13 from the electronics assembly. Place the PWA on an extender board and reinstall into electronics assembly.
2. Connect jumper 13J4 to the A–B position and apply power (Figure 3-45).
3. Connect a SECAM color composite signal to the VPR REF input.
4. Connect scope probe 1 to 13TP6 (SECAM detector) and trigger scope from scope probe 2 at PWA 13 pins 53/54 (H ref).
5. Adjust 13L7 (SECAM 7.8-kHz detector) for negative pulses occurring every other "HI" burst.
6. Scope probe 2 to 14TP4 (probe 1 not used).
7. Put Color Frame PWA back into PWA and set 13S1 to ON (up), and 13S2 to NORMAL (up).

3-59. Control Track PWA 14 (NTSC). Proceed as follows:

1. With power off, remove Control Track PWA 14 from the electronics assembly. Place the PWA on an extender board and reinstall into electronics assembly.
2. Place switch 14S1 (UNITY/VARIABLE) to the UNITY position (up) and apply power (Figures 3-46 and 3-47).

NOTE

Figure 3-48 presents all waveforms for the NTSC control track procedure.

3. Connect scope probe 1 to 14TP5 (CT record signal) and trigger scope off scope probe 2 at PWA 14 pin 59 (FRAME REF). Set scope sweep to 5 ms/cm.
4. Verify that signal is a TTL square wave with a negative leading edge 1/2 field after positive leading edge of frame reference (waveforms 1 and 2 respectively, Figure 3-48). Observe a small positive flag after every other negative transition (channel 1) (waveform 3).
5. Center the positive leading transition of the channel 2 signal on the scope and switch the PWA to variable tracking (14S1 to down position).
6. Vary the tracking control to both ends and verify that the total range is greater than 15 ms (60 Hz).
7. Adjust 14R2 (center position set) to center range of tracking around the unity timing.
8. Adjust variable tracking control to the center of range and observe that when the timing is the same as unity, the control panel TRACKING LED goes out. Verify that tracking control knob is mounted to point straight up.
9. Verify that moving the tracking control off center in either direction lights the TRACKING LED. Verify TRACKING LED blinks if the control is turned greater than 2-1/2 ms off unity.
10. Remove REF video input signal and adjust variable tracking control to one extreme end. Select ASSEMBLE EDIT and place VPR into record mode.
11. Verify that the signal at 14TP5 freezes in position and does not move as tracking control is moved.
12. Turn video input level (control panel) from unity to minimum amplitude (variable) and back to unity. Observe that signal at 14TP5 jumps to the unity position and freezes. Turn editor off.
13. Trigger scope with scope probe 1 at 14TP7 (CF Gate). Verify that square wave at 14TP7 occurs at 1/2 frame rate (waveforms 4 and 5).
14. Connect scope probe 2 to 14A32 pin 2 and ensure a 7.8-kHz signal exists.
15. Place switch 14S2-1 (FLAG REF JAM) in the ON (+) position and select PLAY mode. Verify signal at 14A32 pin 2 is a square wave at a 1/2 frame rate (waveforms 6 and 7 match).
16. Select NORMAL RECORD mode and verify that signal switches to 7.8 kHz for approximately 200 ms and then back to square wave.

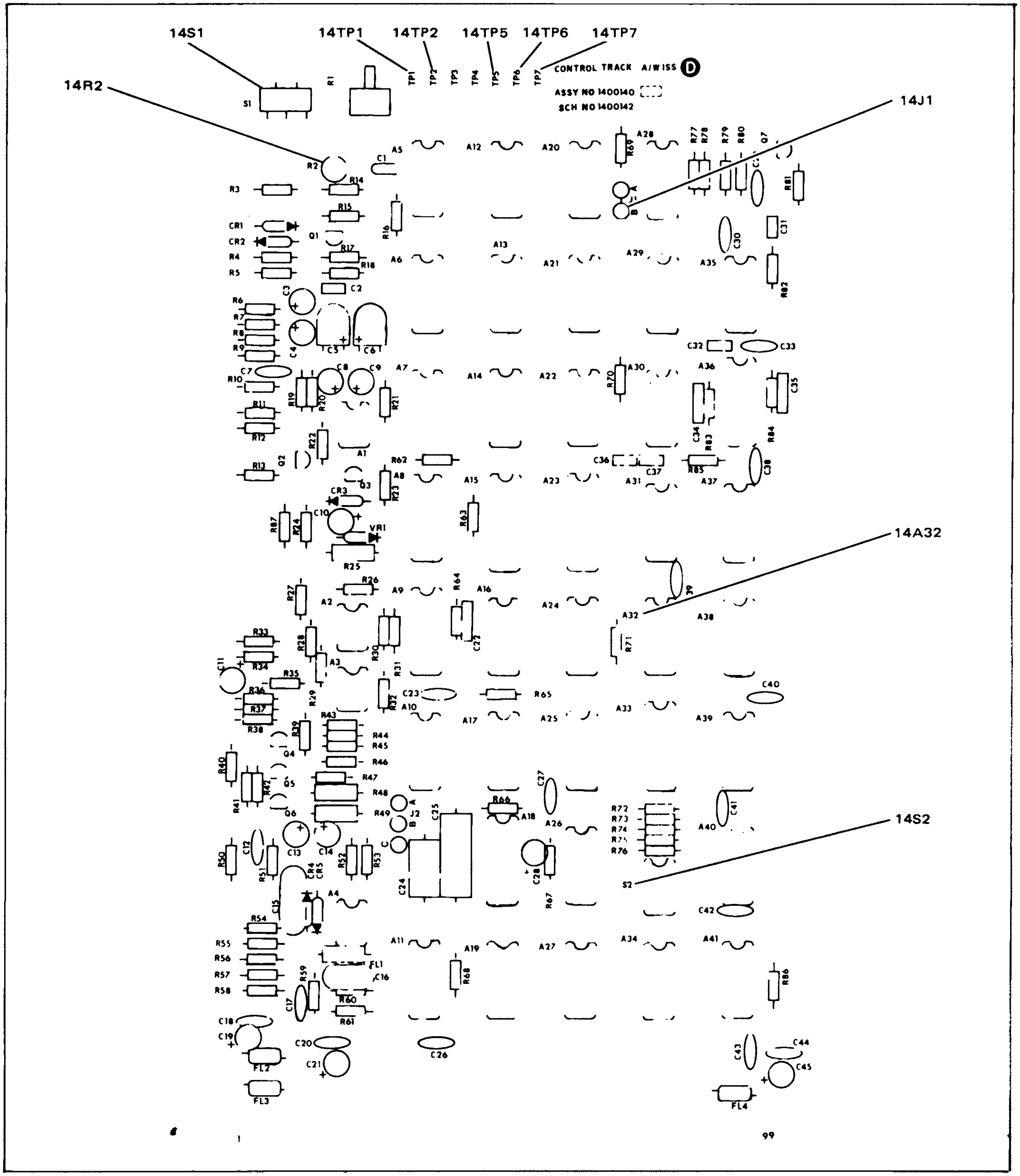


Figure 3-46. Control Track 525 PWA 14, Assembly No. 1400140

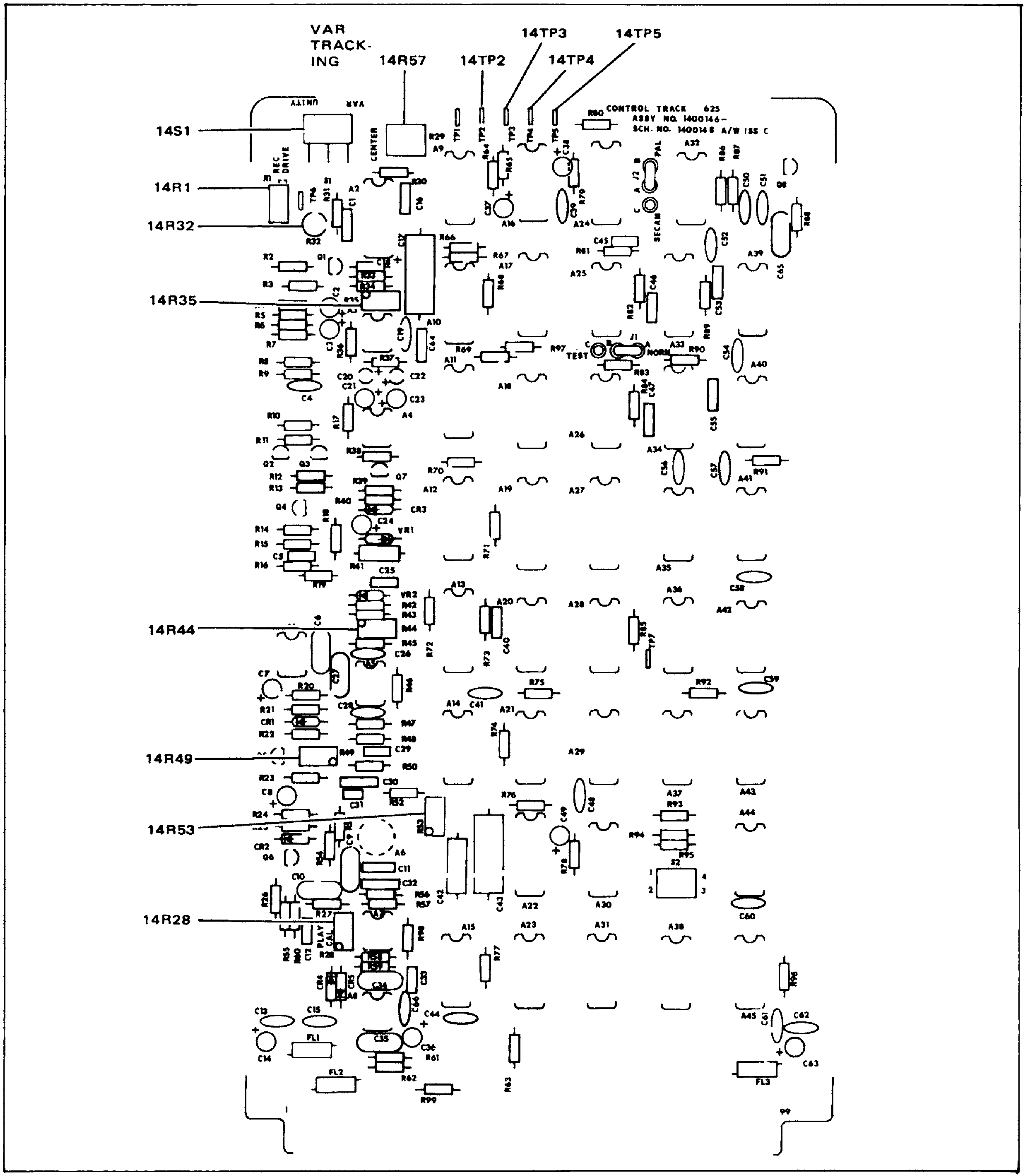


Figure 3-47. Control Track 625 PWA 14, Assembly No. 1400146

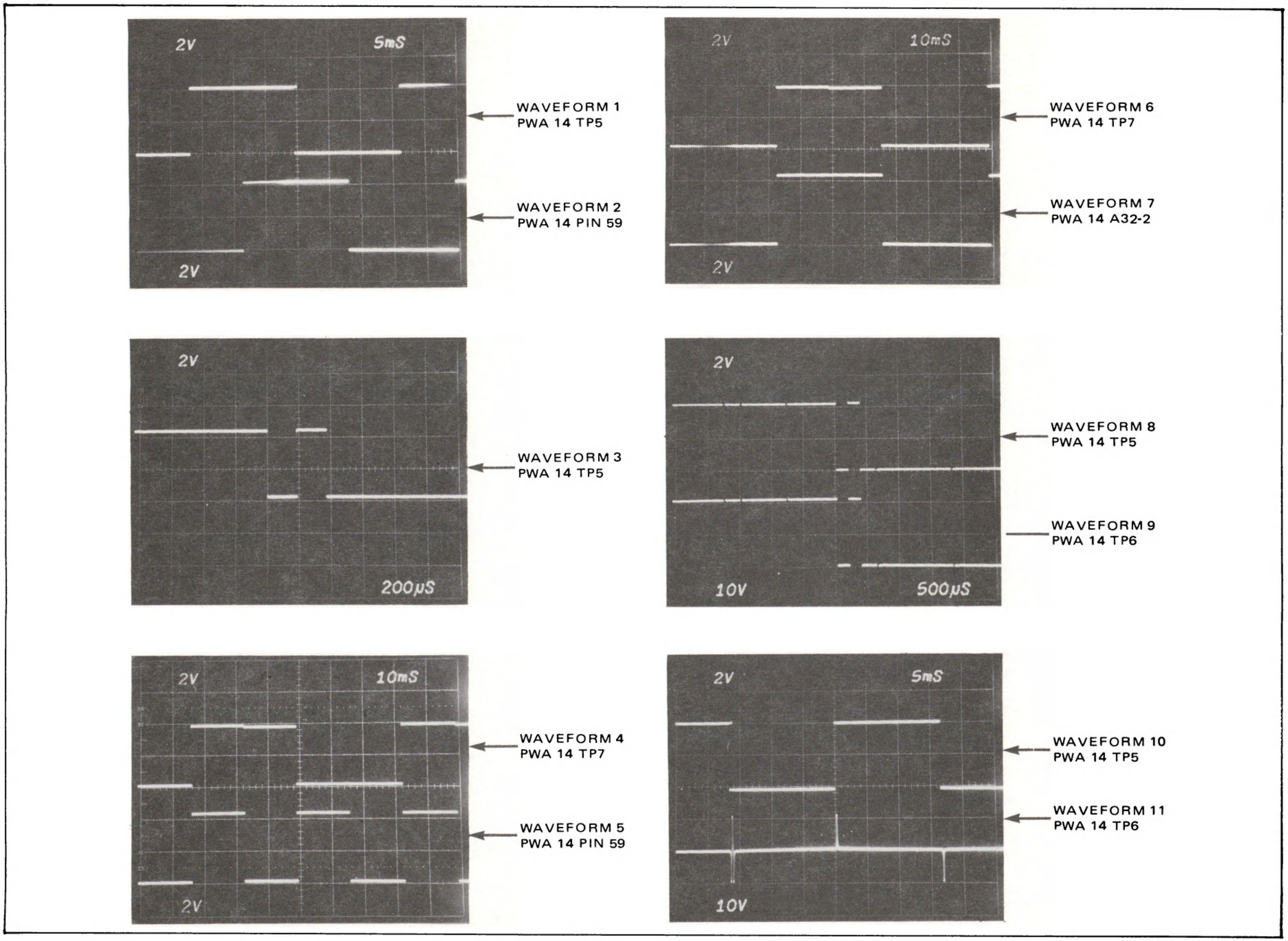


Figure 3-48. Control Track NTSC Waveforms

17. Switch video input to minimum variable level and back to unity. Verify that signal switches to 7.8 kHz (for 200 ms) band back to square wave.

18. Trigger scope externally to 14TP7. Connect scope probe 1 to 14TP5 and scope probe 2 to 14TP6. Set PWA 14 TRACKING switch to UNITY (up).

19. While making a two-minute recording, locate the flag on the signal at 14TP5. Verify the signal at 14TP6 is the same as 14TP5, but at 20 Vp-p (waveforms 8 and 9).

20. Rewind and play the tape and verify that the signal at 14TP6 is a series of positive- and negative-going pulses. Verify that during playback, signal locks up in the same phase at 14TP5 (waveforms 10 and 11).

21. Vary tracking control and verify that playback control-track signal moves along with the signal at 14TP5.

22. Verify that color framer switches are set to ON (up) and NORMAL phase (up) positions. Observe that playback control-track (CT) double pulse is at the same phase as the flag on 14TP5 (waveforms 10 and 11). Cycle from play mode to stop mode and back to play mode several times and verify that signals remain the same.

23. Switch color framer to INVERT (13S2 down) and verify that playback CT has shifted one field with respect to the signal at 14TP5. Repeat this several times.

24. During playback, switch 14S2-2 (EDIT FLAG CONTINUOUS) to ON and verify that the flag at 14TP5 moves to the same place as the P/B control track.

25. Put color frame in INVERT (13S2 down) and lock the playback CT into the invert (down) position.

26. Select ASSEMBLE EDIT RECORD mode and verify that the signal at 14TP5 does not change phase.

27. Return the color framer NORMAL/INVERT switch to normal.

28. Remove jumper 14J1 and, with VPR in play mode, verify that capstan servo LED lights, and that playback CT begins to drift slowly from the locked position.

29. Replace jumper 14J1 and verify that CT signal phases directly back to the proper position without having moved through two complete frames (at TP6) before locking.

30. Connect scope probe 1 to 14TP1 with scope at 1 V/cm dc.

31. With VPR in play mode, depress TSO switch on Capstan Servo PWA 15 and verify the dc level at 14TP1 is at approximately 2.5 Vdc. Verify that when the control track position servo locks again, the signal at 14TP1 displays a correction at a new dc level (increase scope vertical sensitivity as required).

32. Adjust BALANCE control 15R1 (PWA front edge) for the average dc level during CT servo to be identical to that during TSO ±0.1 Vdc.

33. Restore REF cable to VPR REF IN jack. Make a two-minute recording and play it back. After CT is locked, make an assemble edit. Rewind tape and play back recording through the edit.

34. Verify that edit junctions are not visible in the capstan servo system.

35. Verify that capstan servo LED does not blink, and that playback control signal does not jump.

36. Remove PWA 14 and extender board from electronics assembly and reinstall PWA 14 into electronics assembly.

3-60. Control Track PWA 14, EBU Standard. Proceed as follows:

1. With power off, remove Control Track PWA 14 from the electronics assembly. Place the

PWA on an extender board and reinstall into electronics assembly.

2. Set PWA 17 REC LOCKOUT switch to ON. Load onto the VPR the EBU bias control track reference level tape and apply power.

3. Connect scope probe to 14TP2 (Figure 3-47).

4. Play back the standard tape and adjust 14R28 (PLAY CAL) for a 6 Vp-p signal.

5. Rewind the standard tape and remove it from the transport.

6. Thread a work tape onto the transport.

7. Set PWA 17 REC LOCKOUT switch to OFF. Place switch 14S1 (UNITY/VARIABLE) in the UNITY position and degauss the control track head. Select the record mode.

8. Verify the signal at 14TP2 has a high-frequency bias of approximately 2.0 Vp-p with both positive- and negative-going spikes occurring every 20 ms.

9. Place switch 14S1 (UNITY/VARIABLE) in the VARIABLE position and play back the recording.

10. Verify the signal at 14TP2 is still 6 Vp-p (Figure 3-49). If not, adjust 14R1 (CT RECORD LEVEL SET) and make a new recording. Play back the recording and verify the signal. Repeat this step until signal is 6V ±0.1 Vp-p.

11. Trigger scope and scope probe 2 to PWA 14 pin 59 (FRAME REF). Set scope for a 5 ms/cm sweep and connect scope probe 1 to 14TP2.

12. Place switch 14S1 (UNITY/VARIABLE) in the UNITY position and select play mode. Verify that the control track flag pulse occurs at the center of the positive half of the frame reference signal.

13. Adjust 14R29 (VAR TRACKING CONTROL) to midrange and place switch 14S1 (UNITY/VARIABLE) to the VARIABLE position.

14. Adjust 14R32 (RANGE CENTER SET) for the control track flag pulse to be centered on the positive half of the frame reference signal. Verify the tracking LED is not lit. Adjust 14R32 (RANGE CENTER SET) slightly to extinguish LED.

15. Verify that 14R29 (VAR TRACKING CONTROL) will move the flag a minimum of 11 ms in each direction from the unity position.

16. Verify that flag pulse returns to the center of the positive half of the frame reference when switch 14S1 (UNITY/VARIABLE) is placed in the UNITY position.

17. Play back the last recording and, using probe 2, verify that test points 14TP3, 14TP4, and 14TP5 compare to the Timing Chart (Figure 3-49). Probe 1 is on test point 14TP2.

18. Place switch 14S1 (UNITY/VARIABLE) in the VARIABLE position. While adjusting 14R29 (VAR TRACKING CONTROL), verify the signal at 14TP3 shifts in relation to the signal at 14TP2.

19. Remove PWA 14 and the extender board from electronics assembly and reinstall PWA 14 into electronics assembly.

3-61. Capstan Servo PWA 15. Proceed as follows:

1. With power off, remove Capstan Servo PWA 15 from the electronics assembly. Place the PWA on an extender board and reinstall into electronics assembly.

2. Connect scope probe 1 to 15TP5 (run-up time). Set vertical to 5 V/cm sweep to 0.1 sec/cm, and internal trigger (dc couple scope trigger) with negative slope (use NORMAL triggering) (Figure 3-50).

3. Apply power and select play mode. Adjust 15R109 (run-up) for the signal at 15TP5 to be a negative pulse of 0.5 second ±50 ms.

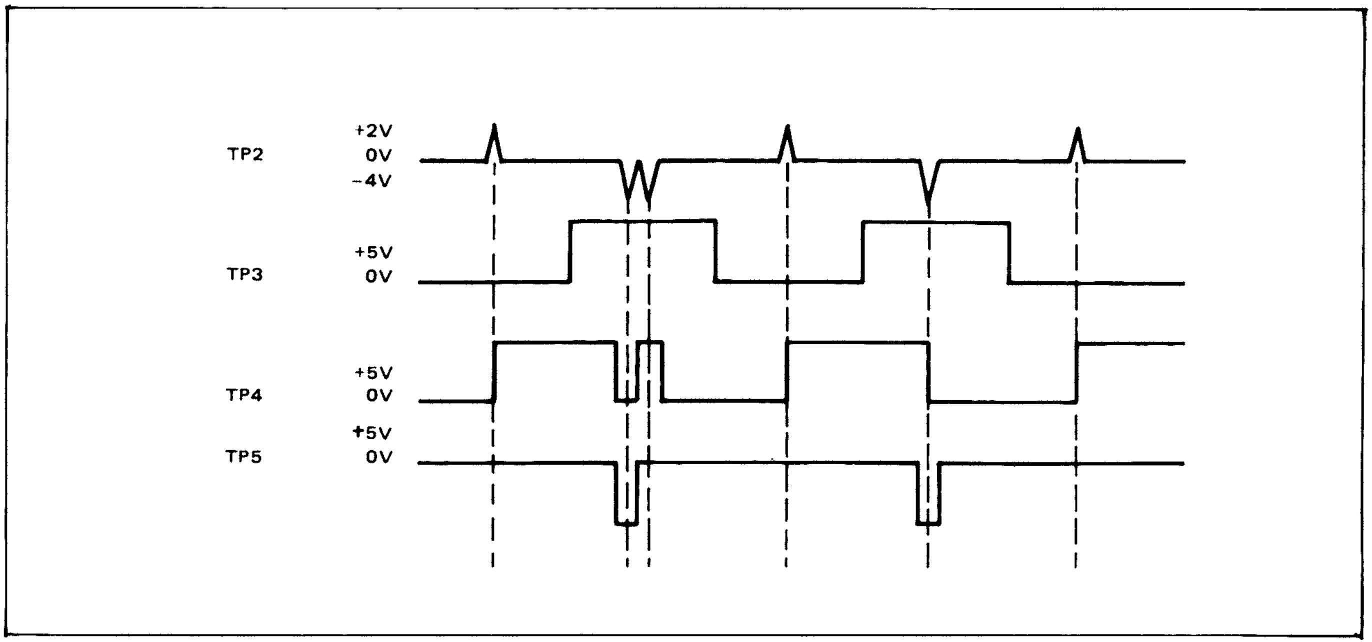


Figure 3-49. Control Track EBU Standard (PWA 14) Timing Chart

4. Verify that steps 30 through 32 of paragraph 5-59, *Control Track PWA 14 (NTSC)*, have been recently done before proceeding.

5. Rotate SHUTTLE knob full clockwise (forward) and press STOP button.

6. Turn SHUTTLE knob fully clockwise, press SLOW button. Observe scope and adjust 15R24 (VAR SPEED LIMIT SET) for a pulse width of 440 microseconds.

7. Press the PLAY button and rotate the SHUTTLE knob full counterclockwise (reverse).

8. Press the SLOW button and verify that the reels coast to a stop, and then start up in reverse direction. Also, verify that the reels do not make a sudden jump from forward play to reverse.

9. Remove PWA 15 and extender board from electronics assembly and reinstall PWA 15 into electronics assembly.

3-62. AST System. The following paragraphs contain test and alignment procedures to ensure proper operation of the AST system.

3-63. AST Servo PWA 9. If a new AST video head is installed, perform the following AST servo adjustment procedure.

NOTE

RESET CAL 9R98 requires a special test equipment to adjust. It should be adjusted only at the factory.

1. Remove tape from the scanner assembly.

2. Remove power for VPR.

3. Remove AST Servo PWA 9 from the electronics assembly. Place the PWA on an extender board and reinstall into electronics assembly.

4. Place jumper 9J1 to sine position and set potentiometer 9R56 (DAMP GAIN) to full counterclockwise position (Figure 3-51).

5. Connect scope probe to 9TP3 (AST null). Trigger scope externally from 11TP4 (scanner tach reference test point on front edge of Scanner Servo PWA 11). (See Figure 3-39).

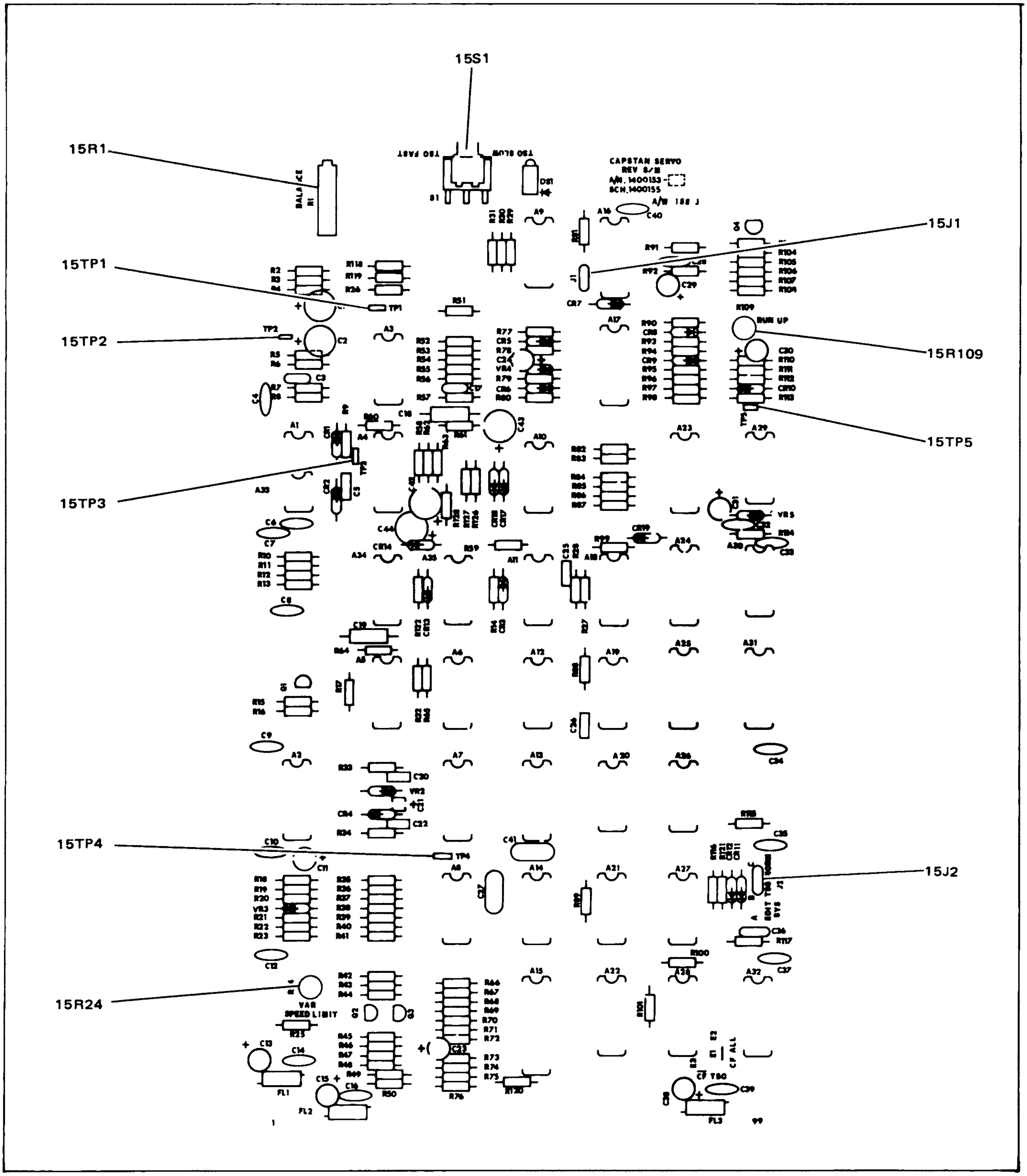


Figure 3-50. Capstan Servo PWA 15, Assembly No. 1400153

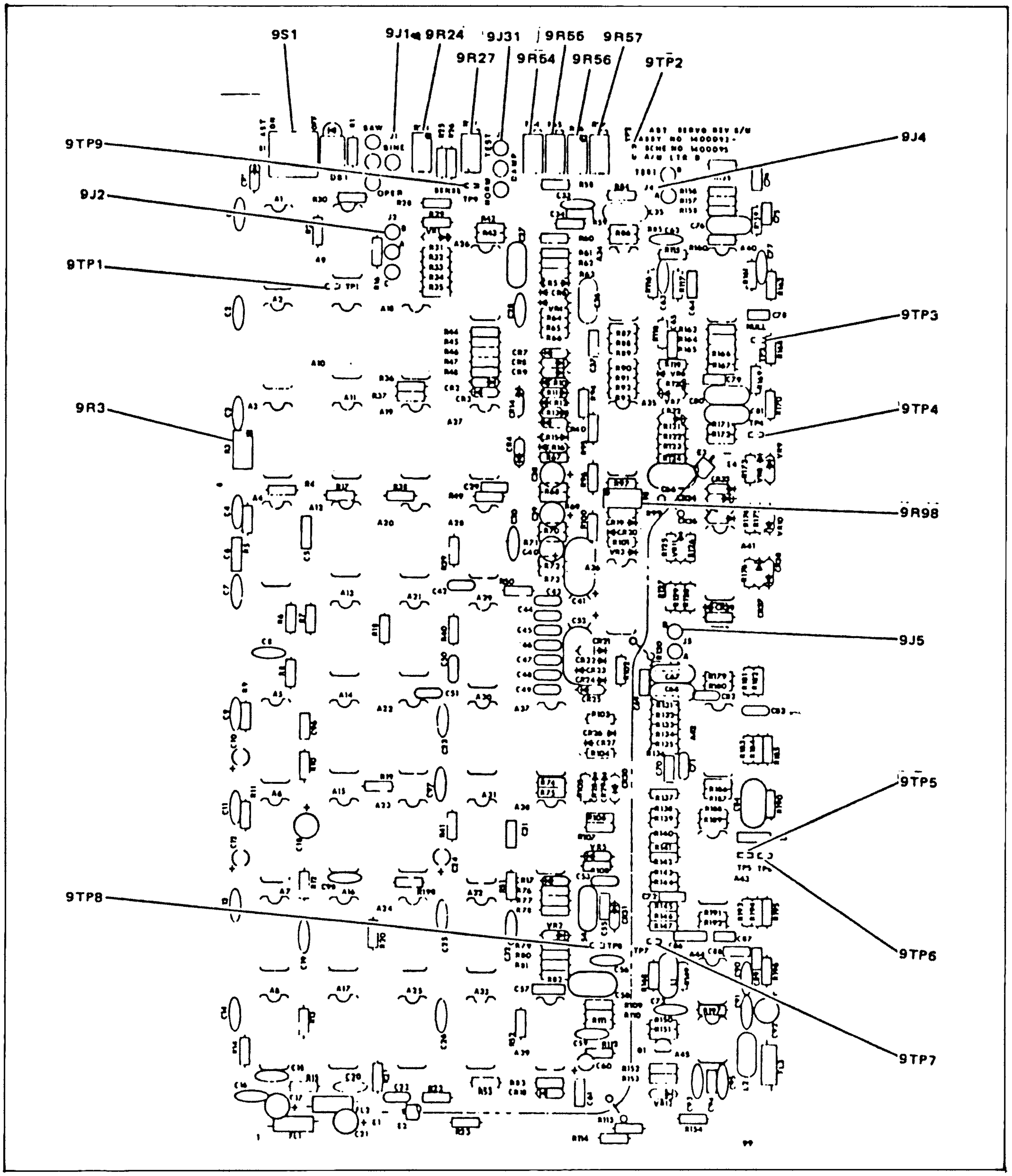


Figure 3-51. AST Servo PWA 9, Assembly No. 1400093 (Accessory)

6. Apply power and enter standby mode with scanner not running.

NOTE

Figure 3-52 presents waveforms for AST procedure.

7. Adjust 9R55 (NULL FREQ) to minimize the 750-Hz component display on the scope. (See waveform 2, Figure 3-52.)

8. Remove power from the VPR.

9. Place jumper 9J1 to SAW position.

10. Move scope probe to 9TP4 (SENSE FEEDBACK). Continue to trigger scope from 11TP4.

11. Apply power to enter standby mode. Reduce scope vertical sensitivity – set horizontal to display one-to-three cycles.

12. Slowly turn 9R56 (DAMP GAIN) in a clockwise direction. Note that the amplitude of the ringing or oscillation on the ramp is reduced as the gain is increased. Continue to adjust 9R56 clockwise until just before the point where no further reduction of the ringing or oscillation is observed. (See waveform 5, Figure 3-52). Note that if 9R56 is turned clockwise beyond the point specified, the sawtooth retrace time will begin to increase. This is an indication of overdamping of the AST head: (See waveform 3; note that waveform 4 shows under damping conditions.

13. Adjust 9R54 (DAMP PHASE) as required for further reduction of ringing just after the transition.

14. Note that controls 9R56 (DAMP GAIN) and 9R54 (DAMP PHASE) are interactive. Readjust the controls for best appearing sawtooth; 9R56 for minimum ringing along the ramp after retrace time without overdamping, and 9R54 for minimum ringing on the ramp immediately after retrace.

15. Move scope probe to 8TP3 (AST head rf test point) on front edge of Playback Sync PWA 8. Select 50 mV/cm sensitivity on scope. Continue to trigger scope from 11TP4.

16. Thread a prerecorded tape onto the VPR.

17. Select ready mode. Shuttle into tape at least one-fourth way.

18. Set VPR for very slow creep of tape in the forward direction, adjust 9R57 (AST CAL) so that the rf envelope on the scope rises and decays uniformly across the full track or field. (See waveform 7; waveform 6 shows 9R57 misadjustment on Figure 3-52.) Misadjustment of 9R57 results in the guard band crossover point moving through the field as the tape is moved.

19. Reinstall jumper 9J1 to the operate position.

20. Select slow-motion reproduce mode with the shuttle/slow-motion knob at the 3 o'clock rotational position.

21. Adjust 9R27 (AST VERN) for maximum stability of the rf envelope (see waveform 9). When 9R27 is slightly misadjusted, the rf envelope appears to flicker (see waveform 8). Further misadjustment causes the servo to lose lock. (See Figure 3-52.)

22. Adjust 9R3 (RESET ϕ) for balanced amplitude on both sides of the dropout interval within the rf envelope. (See waveform 11; waveform 10 slows 9R3 misadjustment.)

23. Shuttle the tape back to beginning of this recording.

24. Observe oscilloscope and press SLOW button. Verify that rf envelope contains no crossovers or glitches from SHUTTLE knob is adjusted from full counterclockwise to full clockwise.

25. Rotate the SHUTTLE knob full counterclockwise (reverse), and observe the dropout area of the waveform.

26. Readjust 9R3 on the AST Servo PWA so that the rf envelope contains no cross-overs and

gives optimum appearance at the beginning and end of the envelope (waveform 11).

27. Adjust 9R27 on the AST Servo PWA for most stable and best looking rf envelope. Press STOP button.

28. Remove power. Remove extender board and reinstall AST Servo PWA 9 into electronics assembly.

3-64. AST Servo Verification. Proceed as follows:

1. Connect scope probe 1 to 8TP3 (rf envelope) and scope probe 2 to 9TP2 (dc correction) with scope at 1 V/cm dc (Figures 3-51 and 3-53).

2. Restore power. Press SLOW button, select still mode and verify the signal at 9TP2, PWA front edge is a negative slope sawtooth at 2 Vp-p (waveform 2, Figure 3-54).

3. Vary VPR from still frame to full speed and verify that sawtooth changes slope and jumps time while rf envelope remains on track throughout range (waveforms 4 and 3, Figure 3-54).

4. Select reverse mode and verify rf envelope continues to track rf.

5. Select shuttle mode and slowly increase forward speed. Verify that slope of signal at 9TP2 changes from negative to positive.

6. Verify that at about 2 X play shuttle speed the signal at 9TP2 is the same as at still frame (except positive slope) with a jump every field (waveform 4, Figure 3-54).

7. Verify that rf envelope stays on track from still mode up to 2 X play speed, but loses lock at any greater speeds.

8. Rewind to previously recorded material and set tracking switch to unity (PWA 14 front edge). Make an insert video edit over the prerecorded material. Verify a good rf envelope with a voltage at 9TP2 at +0.5 Vdc ± 0.2 Vdc.

9. Adjust video record drive control to minimum (full counterclockwise) and verify rf level goes down to near zero. Small "bubbles" of less than 20 mVp-p are permissible.

10. Verify the voltage at 9TP2 is not greater than –0.1 Vdc. It is permissible for the voltage to be slightly positive or to become a sawtooth signal of less than 0.4 Vp-p.

11. Slowly increase record driver gain back to a nominal position and verify that rf level returns to normal amplitude and the signal at 9TP2 jumps back to +0.5 Vdc. Stop recording, but remains in insert mode.

12. Set tracking switch (PWA 14) to VARIABLE. Play back recording and adjust tracking for a voltage at 9TP2 from +1.5 to +1.8 Vdc. Press TSO switch on Capstan Servo PWA 15 and release (slow TSO).

13. Verify that when AST settles down, signal at 9TP2 returns to original position. Repeat steps 12 and 13 several times in both TSO slow and TSO fast. Verify that in all cases the rf envelope remains on track and the voltage at 9TP2 jumps back to +1.5 to +1.8 Vdc.

14. Remove power and place PWA 9 on extender. Restore power. Connect scope probe 1 to PWA 9 pin 17 and observe a TTL low level.

15. Stop the VPR, turn the scanner off, and verify that pin 17 goes to a TTL high level.

16. Turn scanner on (ready mode) and place switch 9S1 (AST ON/OFF) in the OFF (down) position. Verify that the yellow LED (AST NON-STD) on AST Servo PWA 9 lights and pin 17 remains low. Place switch 9S1 in the ON (up) position.

17. Move oscilloscope probe to component/pin 9A35-12 on the AST Servo PWA.

18. Rotate SHUTTLE knob to STOP (detent), and press SLOW button. Oscilloscope should indicate approximately –3.5 Vdc.

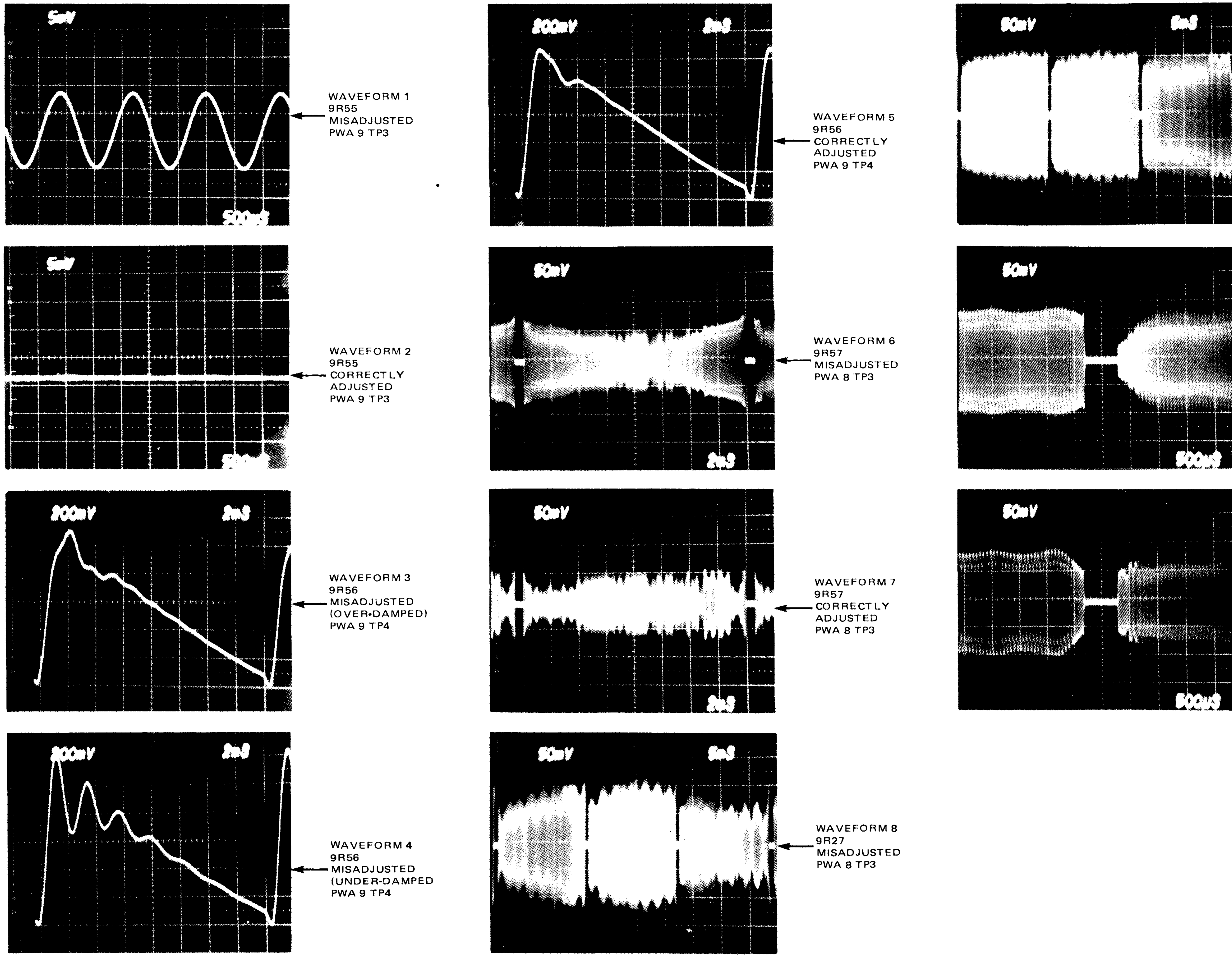


Figure 3-52.
AST Servo Waveforms

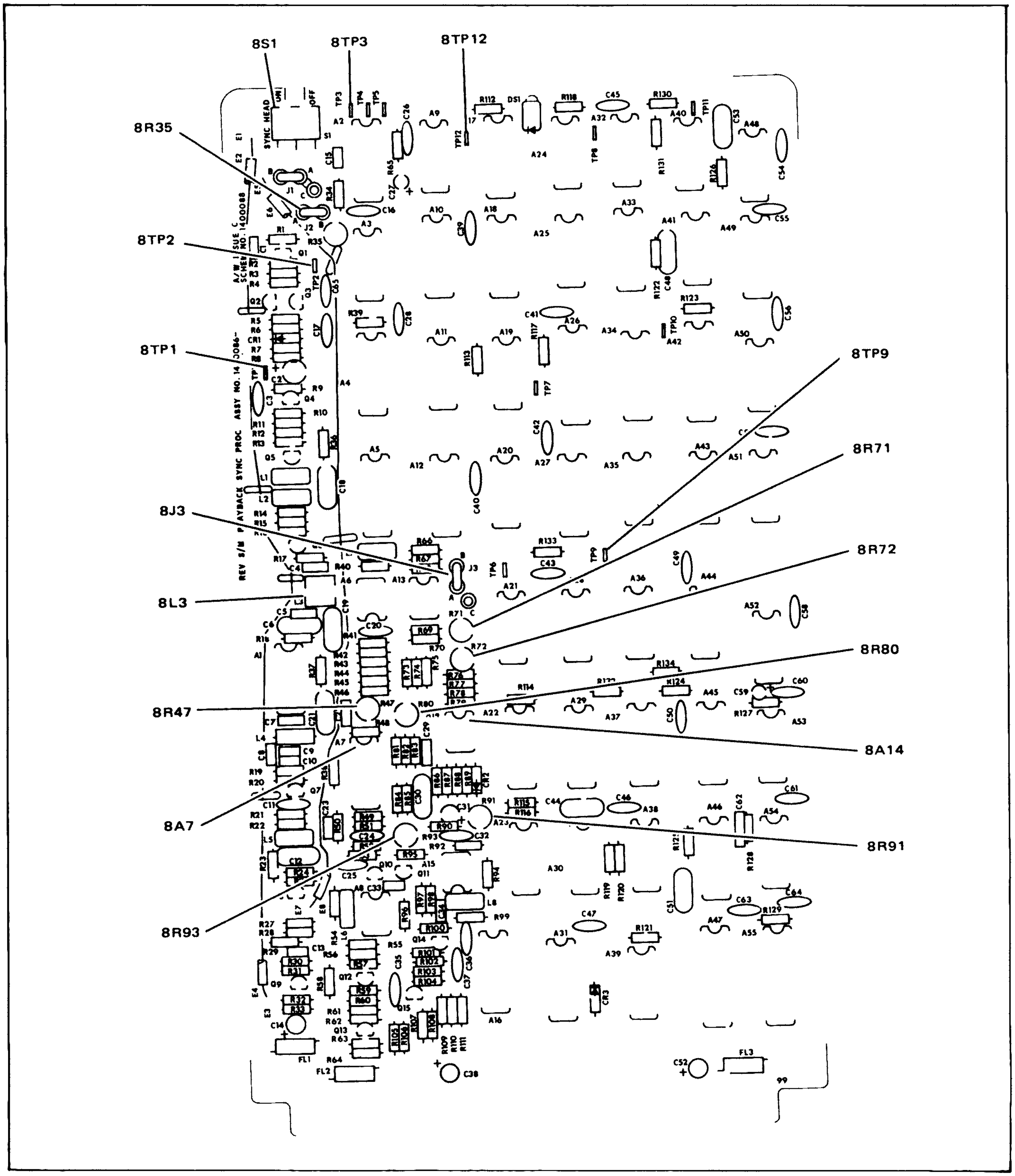


Figure 3-53. AST Playback Sync PWA 8, Assembly No. 1400086

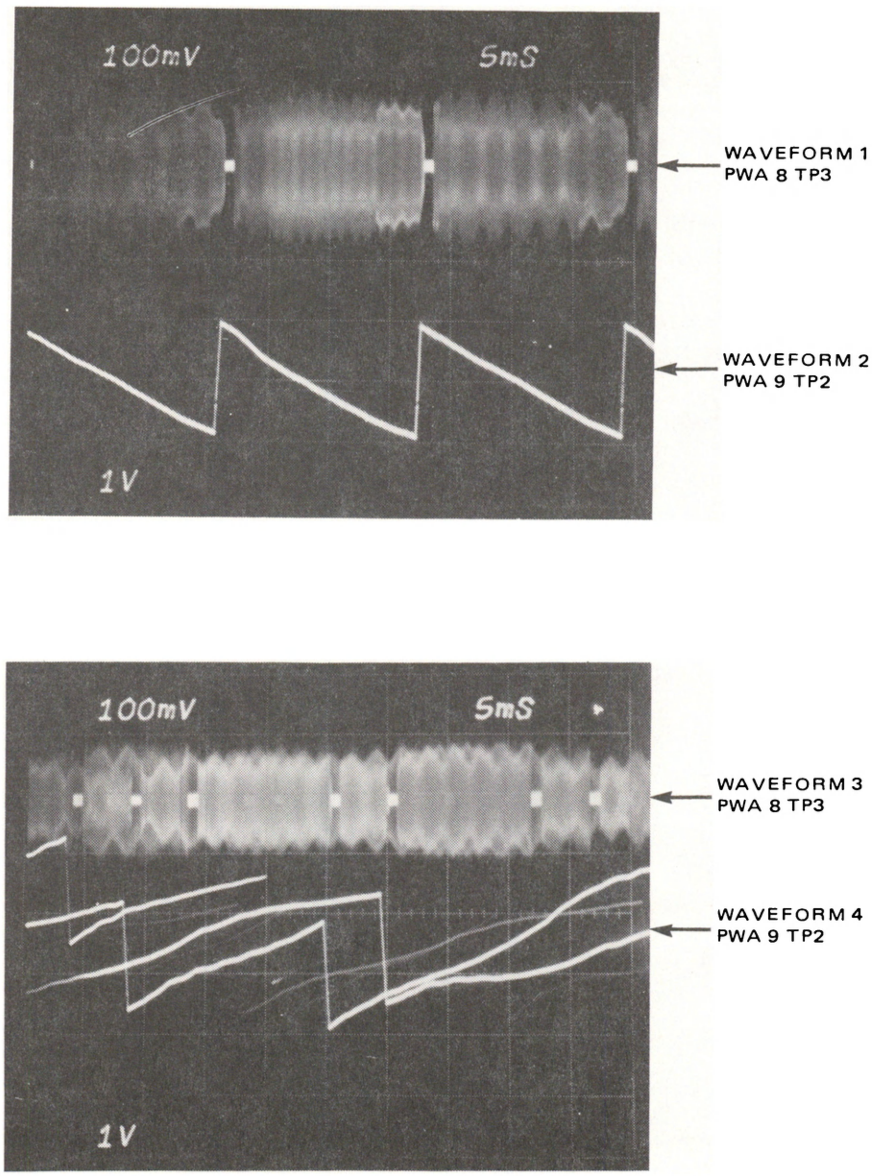


Figure 3-54. AST Servo Verification Waveforms

19. Rotate SHUTTLE knob toward FWD. When the tape speed is approximately one-half play speed, oscilloscope will indicate approximately −1.5 Vdc.

20. Press STOP button, and place scope probe on 9A26-6. Scope should indicate approximately −0.25 Vdc.

21. Rotate SHUTTLE knob full clockwise (forward), and press SLOW button. Scope should indicate approximately +1.5 Vdc.

22. Remove power. Remove PWA 9 and extender board from electronics assembly and reinstall PWA 9 into electronics assembly.

3-65. AST Filter PWA 10. Figure 3-55 presents waveforms for this procedure. Proceed as follows:

1. With power off, remove AST Filter PWA 10 from the electronics assembly. Place the PWA on an extender board and reinstall into electronics assembly.

2. Set jumper 10J1 to A–C, jumper 10J2 to 60 Hz (50 Hz), and jumper 10J3 to normal. Place switch 10S1 (AST RANGE) in the EXT position (up) (Figure 3-56). Power up VPR and select still frame mode.

3. Adjust 10R45 (100/120 Hz) and 10R39 (150/180 Hz) fully clockwise. Connect scope probe 1 to 10TP4 and verify the presence of a 60-Hz (50-Hz) sine wave. Trigger scope at PWA 14 TP4 (Waveform 1, Figure 3-55).

4. Adjust 10R53 (50/60 Hz) for a maximum peak signal.

5. Adjust 10R44 (GAIN) for 0.5 Vp-p.

6. Connect scope probe 1 to 10TP2. Adjust 10R45 (100/120 Hz) for a signal comparable to waveform 2 of Figure 3-55.

7. Adjust 10R39 (150/180 Hz) for flattest bottom in the waveform.

8. Set jumper 10J1 to B–C (normal), jumper 10J3 to B–C (test, and switch 10S1 (AST RANGE) to NORM positions.

9. Connect scope probe 1 to PWA 10 pin 64 (variable reference trigger) and scope probe 2 to pin 68. Adjust 10R103 (CENTER CONTROL) for a 254 μs difference between the negative edge of pin 64 and the positive edge of pin 68 (Variable Reference). (Waveforms 3 and 4 respectively).

10. Set jumper 10J3 to NORM position. Connect scope probe 1 to 11TP3 (PH ERROR). Trigger scope externally from PWA 10-pin 67. Verify jumper 11J2 is in A–B position, and 11J1 is in AUTO position. Use scope delay time-base mode to display scanner servo phase error at 11TP3. Waveforms 6 and 5 (Figure 3-55) show correct and incorrect adjustment respectively. Place VPR in SLOW mode at about one-fifth play speed forward. Adjust 10R115 for minimum pulse width as shown in waveform 6. With power removed restore PWA 10 to electronics assembly.

3-66. Playback Sync Processor PWA 8. Figure 3-57 presents waveforms for this procedure. Proceed as follows:

1. With power off, remove Playback Sync Processor PWA 8 from the electronics assembly. Place the PWA on an extender board and reinstall into electronics assembly.

2. Apply power, select standby mode, and turn scanner off. Connect scope probe 1 to 8A7 pin 1 (Figure 3-53). Trigger scope at PWA 14 TP4 (front edge).

3. Adjust 8R80 (RECORD HD METER ZERO) until voltage just goes positive. Then adjust 8R80 back until voltage quits negatively (at approximately 0 to +0.2V).

4. Connect scope probe 1 to 8A7 pin 7 and adjust 8R93 (SYNC METER ZERO) just as in step 3 above.

5. Connect scope probe 1 to 8A7 pin 14 and adjust 8R47 (PLAY HD METER ZERO) just as in step 3 above.

6. Select normal play, turn AST servo off, and play back a previously recorded tape.

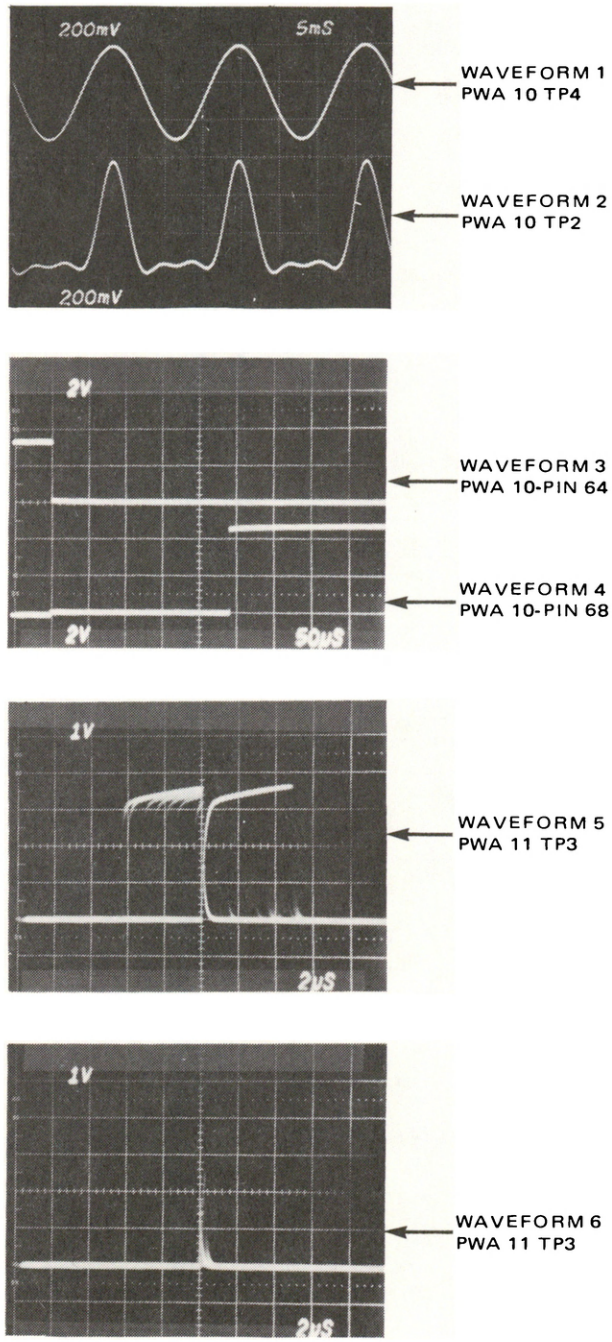


Figure 3-55. AST Filter Waveforms

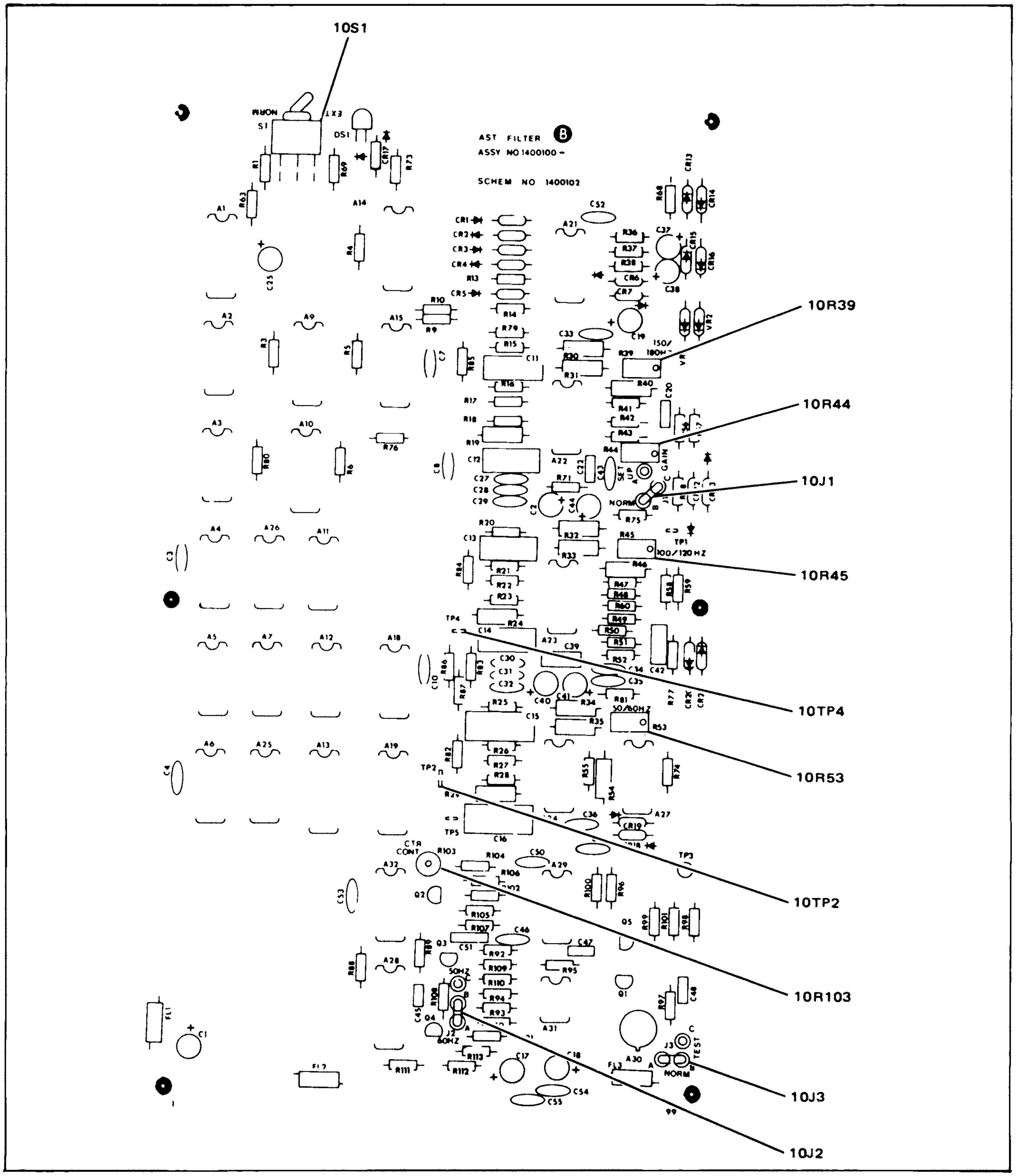


Figure 3-56. AST Filter PWA 10, Assembly No. 1400100

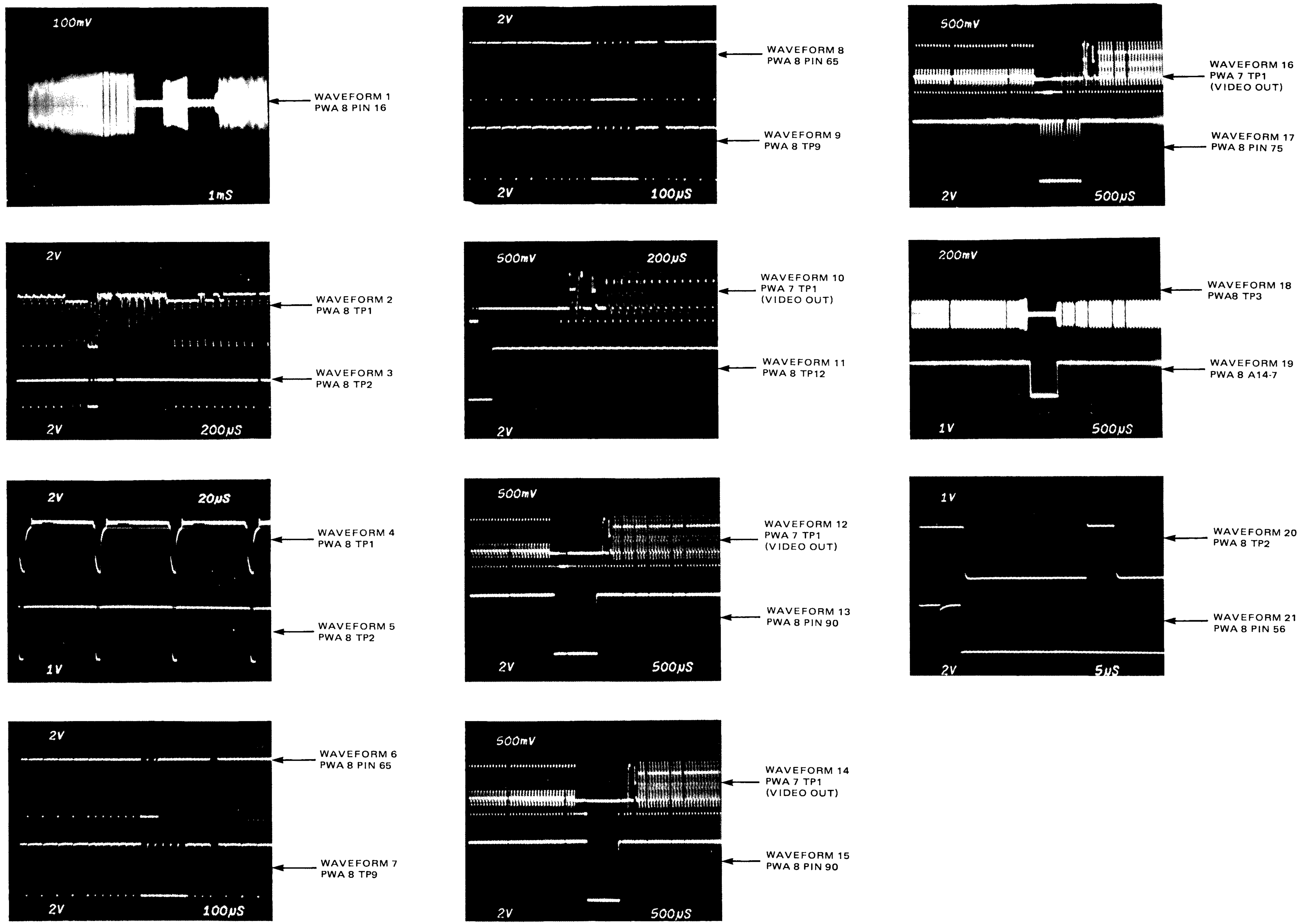


Figure 3-57.
Playback Sync Waveforms

7. Connect scope probe 1 to PWA 8 pins 17/18 (play head rf). Set UNITY/VARIABLE switch (14S1) to VAR position and adjust tracking for maximum rf amplitude between 150 to 200 MVp-p. Adjust 8R71 (PLAY RF METER CAL) to center reading of rf meter in the green band.

8. Connect scope probe 1 to PWA 8 pin 16 (sync head rf). While ignoring the main field rf, verify that sync period rf is between 150 to 200 Vp-p (waveform 1, Figure 3-57). While holding the meter select switch in the SYNC position, adjust 8R91 (SYNC METER CAL) to center meter reading in the green band.

9. Place editor in insert mode and release meter switch. Connect scope probe 1 to PWA 8 pin 13 (record head rf) and verify that signal is between 150 and 200 mVp-p. Adjust 8R72 (RECORD HD METER CAL) to center meter reading in the green band.

10. Connect scope probe 1 to 8TP1 (record head demod). Select insert mode, start playback, and peak tracking control. While observing the distorted video signal adjust 8L3 (demod setup) for maximum negative-going sync signal amplitude (waveforms 2 and 4, Figure 3-57). Note that video will be clipped. Connect scope probe 1 to 8TP2 and verify that composite sync is present (waveforms 3 and 5, Figure 3-57).

11. Turn PWA 9 AST ON/OFF switch to ON (up). Adjust 8R35 (EDIT PHASE) and verify that video moves on scope. Adjust 8R35 until video is coincident with vertical reference ±4 μs. Alternate between play and stop mode several times – verify coincidence is regained each time.

12. Trigger scope at 14TP2 (frame reference) or 14TP3 on EBU version. Set sweep to 100 μs/cm. Connect scope probe 1 to PWA 8 pin 65 (comp sync) and scope probe 2 to 8TP9 (P/B sync comp sync reinsert) (refer to waveforms 6 and 7, Figure 3-57).

13. Stop the VPR and place TAPE/EE switch to the EE position. Verify that the composite sync signal at 8TP9 exactly matches the sync signal of the demod video (use scope delay) (Waveforms 8 and 9).

14. Trigger scope on 8TP9 and expand to look at horizontal rate. Verify sync at 8TP9 matches the video sync ±0.3 μs. Switch TAPE/EE switch from EE to TAPE and back to EE several times. Verify that the horizontal and vertical sync match the video each time. Leave switch in TAPE position.

15. Connect scope probe 2 to 8TP12 (P/B vert). Trigger scope on 8TP12 and set sweep to 0.2 ms/cm. Connect scope probe 1 to 7TP1 (VIDEO OUT) or to I/O panel MONITOR VIDEO OUT connector and observe first line of field video.

16. Select slow mode and play prerecorded video. With the exception of a 1/2-line jump when the AST head switches fields, verify that the video remains stable (waveforms 10 and 11).

17. Verify that the video does not jump more than 1/2 line for all speeds from still frame to 1-1/4 play speed, and still to 1/4 reverse slow speeds.

18. Trigger scope on frame reference 14TP2 (525) or 14TP3 (625). Connect scope probe 2 to PWA 8 pin 90 (DO/vert to TBC). Select playback mode and place sync head playback switch to ON.

NOTE

Steps 19 through 22 apply to the sync head equipped machines only.

19. Set tracking to unity while playing prerecorded material. Expand sweep to view off-tape vertical interval. Verify that there is continuous video through the vertical interval (waveforms 12 and 13).

20. Verify that the TTL pulse has gone negative (with a small switching "glitch" on the video) between the third and fourth equalizing pulses before vertical sync.

21. Verify that the TTL pulse goes positive three to five microseconds before video line 15 with another small switch "glitch." Verify that neither video switch exhibits noise and shall be approximately 1 μs signal at the blanking level.

22. Place the sync head P/B switch in the OFF position and verify that the demod video disappears after the vertical broad pulses have begun and reappears before video line 14 (waveforms 14 and 15).

23. Verify that the TTL pulse goes negative near or after the video broad pulses and goes positive before video line 15. Connect scope probe 2 to PWA 8 pin 55 (TBC vert).

24. Verify that the TTL pulse goes negative at the same instant as the first video broad pulse out of demod and goes positive just prior to the first video line containing color burst.

25. Connect scope probe 2 to PWA 8 pin 75 (2H gate to TBC) and verify that signal is a TTL high through most of the video field. Verify that the signal is positive during the horizontal sync pulses during the vertical sync dc interval. Verify the signal is a negative pulse centered on every other video equalizing pulse (waveforms 16 and 17).

26. Select normal playback mode and connect scope probe 1 to 8TP3 (P/B video rf). Connect probe 2 to 8A14 pin 7 (dropout detected interval) and observe a TTL low pulse across the entire rf dropout interval (waveforms 18 and 19).

27. Connect scope probe 2 to PWA 8 pin 32 and, with jumper 8J3 set in the A–B position, observe a TTL high level.

28. Mistrack the VPR (using PWA 14 controls) until the rf level at 8TP3 is at minimum amplitude. Verify that the TTL level at pin 32 remains high. Select standby mode and verify that TTL level at pin 32 goes low (scanner not running).

29. Start scanner to initiate still mode operation. Verify TTL level at pin 32 is high when near or at locked operation. It is permissible for TTL level to pulse while scanner is starting up.

30. Place scanner servo switch to AUTO, AST switch to ON, editor to INSERT, and TAPE/EE switch to EE. Connect scope probe 1 to 8TP2 (composite sync) and scope probe 2 to PWA 8 pin 56 (vertical reference).

31. Expand scope sweep to 5 μs/cm and center the negative edge of the vertical reference on the scope. Select playback mode and allow the VPR to settle down.

32. Verify that demod video is positioned with the leading edge of the vertical sync coincident with the vertical reference ± 4 μs. Gently rock the tracking control back and forth and verify that video moves and then "slides". back to the proper position (waveforms 20 and 21).

33. Place the TAPE/EE switch in the TAPE position. Remove power and remove PWA 8 and extender board from electronics assembly and reinstall PWA 8 into electronics assembly. Restore power.

34. Turn on power and depress SLOW switch. observe picture monitor and vary the SHUTTLE knob to FWD and back to REV. Verify that picture does not move vertically more than 1/2 line for all speeds.

35. Press the READY button.

36. Press PLAY button.

37. Press STOP button and verify that there is no picture movement.

38. Press PLAY button and verify that there is no picture movement.

39. Press SLOW button, and verify that there is no picture movement.

40. Press STOP button and verify that there is no picture movement.

41. Rotate SHUTTLE knob to FWD.

42. Press SLOW button and verify that there is no picture movement.

43. Press STOP button, and verify that there is no picture movement.

44. Rotate SHUTTLE knob to REV, and press the SLOW switch.

45. Press PLAY button, and verify that there is no picture movement.

46. Press SLOW button, and verify that there is no picture movement.

47. Press STOP button and rotate the SHUTTLE knob to FWD.

48. Press SLOW button.

49. Press PLAY button, and verifv that there is no picture movement.

50. Press SLOW button, and verify that there is no picture movement.

51. Press the STOP button.

3-67. Selected TBC-2B System Adjustments. The procedure below has been performed at the factory at the time of manufacture. It should not be repeated in the field unless the need is certain; need is denoted by horizontal position shift of the picture. Make selected TBC-2B adjustments as follows:

1. Place the TBC-2B Video Input PWA (slot 3 of the TBC-2B) and TBC-2B Tape H PWA (slot 5 of the TBC-2B) on extender boards.

2. Set the TAPE/EE switch to EE.

3. Place dual trace oscilloscope channel 1 probe on test point TP9 and channel 2 probe on test point TP15 of the Video Input PWA. Restore VPR power. Sync the oscilloscope external negative on the channel 1 input. Waveforms should appear as in Figure 3-58.

4. Adjust R239 (Sync Delay) on Video Input PWA for a time difference in the leading edges of 0.95 microseconds.

5. Press PLAY button, and adjust R1 (BURST SYNC ϕ) on the Tape H PWA (accessible from board edge) for an indication of +4.00 ±0.05 Vdc at U44-8 on Tape H PWA. Measure with a digital voltmeter.

6. Rotate SHUTTLE knob to STOP (detent), and press SLOW button. Verify with digital voltmeter that voltage at U44-8 on the Tape H PWA is +4.2 ±0.1 Vdc. If it is, skip step 7 below and proceed to step 8.

NOTE

Verify that EDIT READY indicator is lighted, indicating that system is color framing.

7. Very carefully adjust R239 on Video Input PWA for a digital voltmeter indication of +4.20 ±0.05 Vdc. Then repeat steps 5 and 6 above.

8. Verify that the leading edge time difference between waveforms at TP9 and TP15 on Video Input PWA is 0.95 ±0.05 microseconds.

9. Rotate SHUTTLE knob to REV. Then alternately press PLAY and SLOW buttons. Verify that EDIT READY indicator is lighted, indicating that system is color framing. Observe right-hand edge of monitor display and verify that horizontal position does not shift.

10. Remove the Video Input and Tape H PWA's from board extenders and reinstall them in slots 3 and 5 of the TBC-2B, respectively.

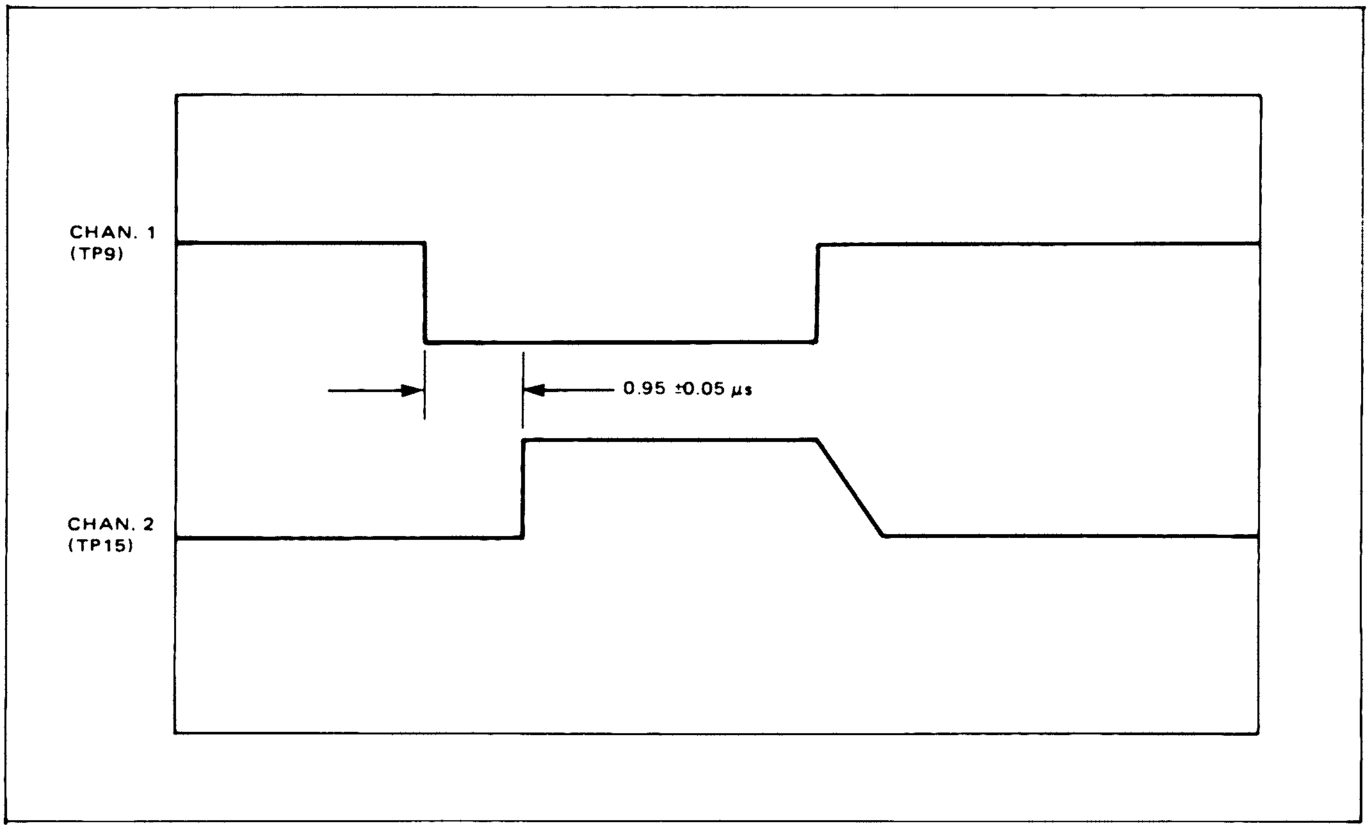


Figure 3-58. Delay Between Off-Tape Sync and Process Sync

3-68. Video Signal System

The following paragraphs contain alignment procedures for ensuring proper operation of the video signal system. These alignment procedures were performed at the factory, and need be repeated only when a repaired or replacement PWA is installed into the recorder.

3-69. Modulator PWA 6 Adjustments. Before commencing, verify that the levels for all video input signals are as follows: For NTSC – 1 Vp-p, 0.714 volts video, 0.286 volts sync, 0.286 volts burst; for PAL – 1 Vp-p, 0.700 volts video, 0.300 volts sync, and 0.300 volts burst. Refer to Figures 3-59 and 3-60 for component locations while doing the procedure below. Adjustment to potentiometers 6R1 (VIDEO RECord LEVEL) and 6R65 (SYNC RECord LEVEL) is covered under the *Video/Sync Record Optimization* procedure, paragraph 3-70. For all other Modulator PWA adjustments, proceed as follows:

1. Connect a television signal generator to the VIDEO IN connector, VPR rear panel. Set generator controls to provide a sine-squared pulse and bar signal.

2. With power off, remove Modulator PWA from slot 6. Position jumpers:

6J2	A–B	6J5	A–C
6J3	remove	6J6	remove

   Place Modulator PWA on extender and plug extender/PWA into slot 6. Restore Power.

3. Connect scope channel 1 to TL1.

4. Adjust (first) 6C34 and (second) 6R37 for a null at pin 6 (increase scope sensitivity as required).

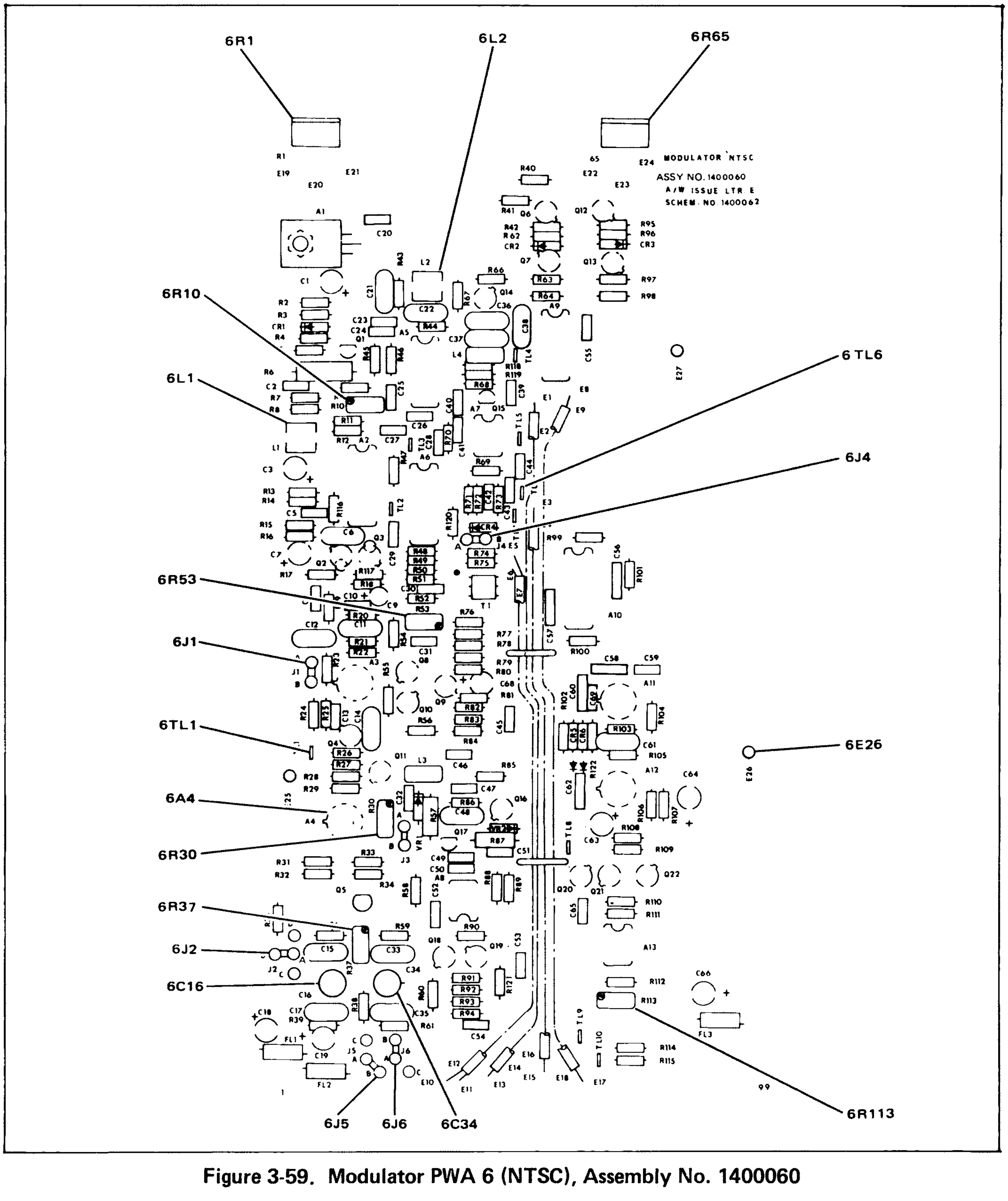


Figure 3-59. Modulator PWA 6 (NTSC), Assembly No. 1400060

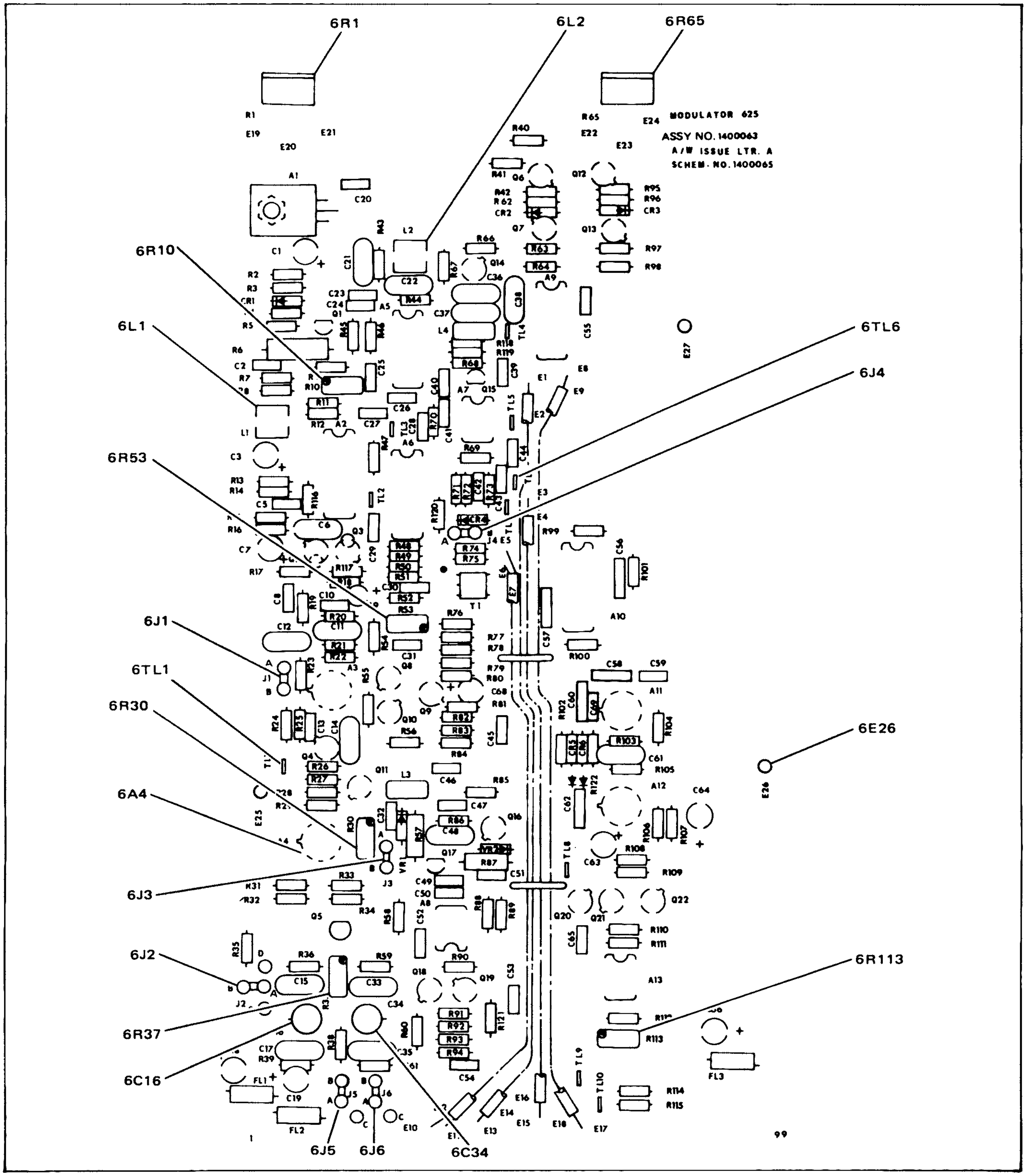


Figure 3-60. Modulator PWA 6 (625), Assembly No. 1400063

5. Reduce scope vertical sensitivity.

   a. Set jumper 6J6 to A–B, and remove 6J5.

   b. Adjust 6C16 for flat bar response (signal should not be distorted from input signal).

6. Repeat steps 1 and 2 until no further interaction occurs.

7. Set VIDEO RECORD LEVEL switch (front panel) to UNITY (in) position. Set EE/TAPE switch to EE.

8. Connect a stairstep signal to the VIDEO INPUT connector.

9. Connect spectrum analyzer probe (use 10 to 1 attenuation) from analyzer RF INPUT to PWA 6 pins 55/56 (EE RF OUT). Center the display on the spectrum analyzer.

10. Position jumpers:

6J1	remove	6J4	remove
6J2	A–B	6J5	A–B
6J3	A–B	6J6	A–B

11. Adjust 6R53 for a blanking (carrier) frequency of 7.9 MHz (7.68 MHz).

12. Adjust 6R30 (UNITY) for a peak white frequency of 10.0 MHz, SMPTE (8.9 MHz, EBU). Verify that both the 7.9 MHz SMPTE (7.68 MHz, EBU) blanking frequency and the 10.0 MHz, SMPTE (8.9 MHz, EBU) peak white frequency are correct.

13. Adjust AFC loop

   a. Position jumper 6J4 to A–B.

   b. If required, adjust variable inductor 6L2 for blanking frequency of 7.9 MHz (7.68 MHz). Verify that the peak white frequency remains at 10.00 MHz (8.9 MHz). If so required, repeat step 12 to readjust 6R30 for this frequency.

14. Calibrate video level meter. Select VIDEO level on front panel video level meter (use meter select switch). Adjust 6R113 so video level meter reads in the middle of the green area.

15. Calibrate demodulator video level. Remove power and withdraw Modulator PWA/extender; restore PWA to slot 6. Withdraw the Demodulator PWA from slot 5; plug Demodulator PWA/extender into slot 5. Restore power. Connect scope channel 1 to PWA 5 pins 79/80 (VIDEO 1 OUTPUT). Adjust 5R211 (see Figures 3-61 and 3-62) for a video output level of 0.714 Vp-p (0.700V PAL) from blanking to peak white. (Note: The blanking level should be at 0 Vdc.) Video 1 output must be terminated into exactly 75 ohms.

16. Adjust modulator linearity. Remove power and withdraw Demodulator PWA/extender from slot 5; separate the two and restore PWA to slot 5. Withdraw Modulator PWA from slot 6 and place it on the extender; plug extender/Modulator PWA into slot 6. Restore power. Connect scope channel 1 to VIDEO 1 test point, front edge of Video Bypass PWA. If Video Bypass PWA is replaced by the Character Generator PWA (option), access VIDEO 1 at the rear panel using a BNC-T connector.

17. Adjust modulator low frequency linearity. With sine-squared pulse and bar signal input to the machine, adjust 6R10 (LINearity adjust) to achieve a bar tilt of 1%or less.

18. Change television signal generator controls to provide a modulated ramp to the VIDEO IN connector. Connect vectorscope VIDEO 1 OUTPUT at rear panel.

19. Adjust variable inductor 6L1 to achieve a differential gain of 2% or less. Note that the differential phase should be 2° or less (use vectorscope to observe). If this value is not attainable, it indicates component failure or other fault. Troubleshoot per standard practices.

20. Repeat steps 17 through 19 until no further improvements can be made.

21. Position Jumpers:

J1	A–B	J4	A–B
J2	A–B	J5	A–B
J3	A–B	J6	A–B

3-70. Video/Sync Record Optimization.

1. Load a bulk-erased tape on the VPR. Power-up machine.

2. Connect television signal generator to VIDEO IN connector.

3. Set generator controls to provide color bars.

4. Set VPR switches:

   a. VIDEO RECORD ENABLE to ON.

   b. TAPE/EE to TAPE position.

5. Optimize video record head:

   a. Meter select switch (front panel) remains in VIDEO RF position.

   b. Initiate record mode.

   c. Adjust video record level potentiometer 6R1 for maximum reading on video rf meter at the least clockwise position.

6. Optimize sync record head (applies to sync equipped machines only):

   a. Set SYNC RECORD ENABLE switch to ON.

   b. Set meter select switch to SYNC RF position.

   c. Initiate record mode.

   d. Adjust sync record level potentiometer 6R65 for maximum reading on sync rf meter at the least clockwise position.

3-71. Demodulator PWA 5 Adjustments. Refer to Figures 3-61 and 3-62 for component locations while doing the procedures below.

1. Remove power. Extract Demodulator PEA and place it on the extender. Insert PWA/ extender into slot 5 and restore power.

2. Set front panel controls:

   a. TAPE/EE switch to EE.

   b. VIDEO RECORD LEVEL control to UNITY position (in).

   c. VIDEO RECORD ENABLE to ENABLE position (up).

3. Connect television signal generator output to VIDEO IN connector, VPR rear panel. Set generator controls to provide a multiburst signal.

4. Connect scope probe to PWA 6 pins 79/80 (VIDEO 1 OUT). Video 1 output must be terminated into 75-ohms.

5. Verify multiburst frequencies are correct to 4.2 MHz. Use scope delay to observe each frequency burst in turn; measure the period visually to confirm that the frequency is correct for each burst.

6. Adjust variable capacitor 5C83 for a flat frequency response, as observed on scope.

7. Set signal generator controls to provide color bars.

8. Adjust 5R217 so that burst amplitude is equal to sync amplitude (0.286V NTSC, 0.300V PAL).

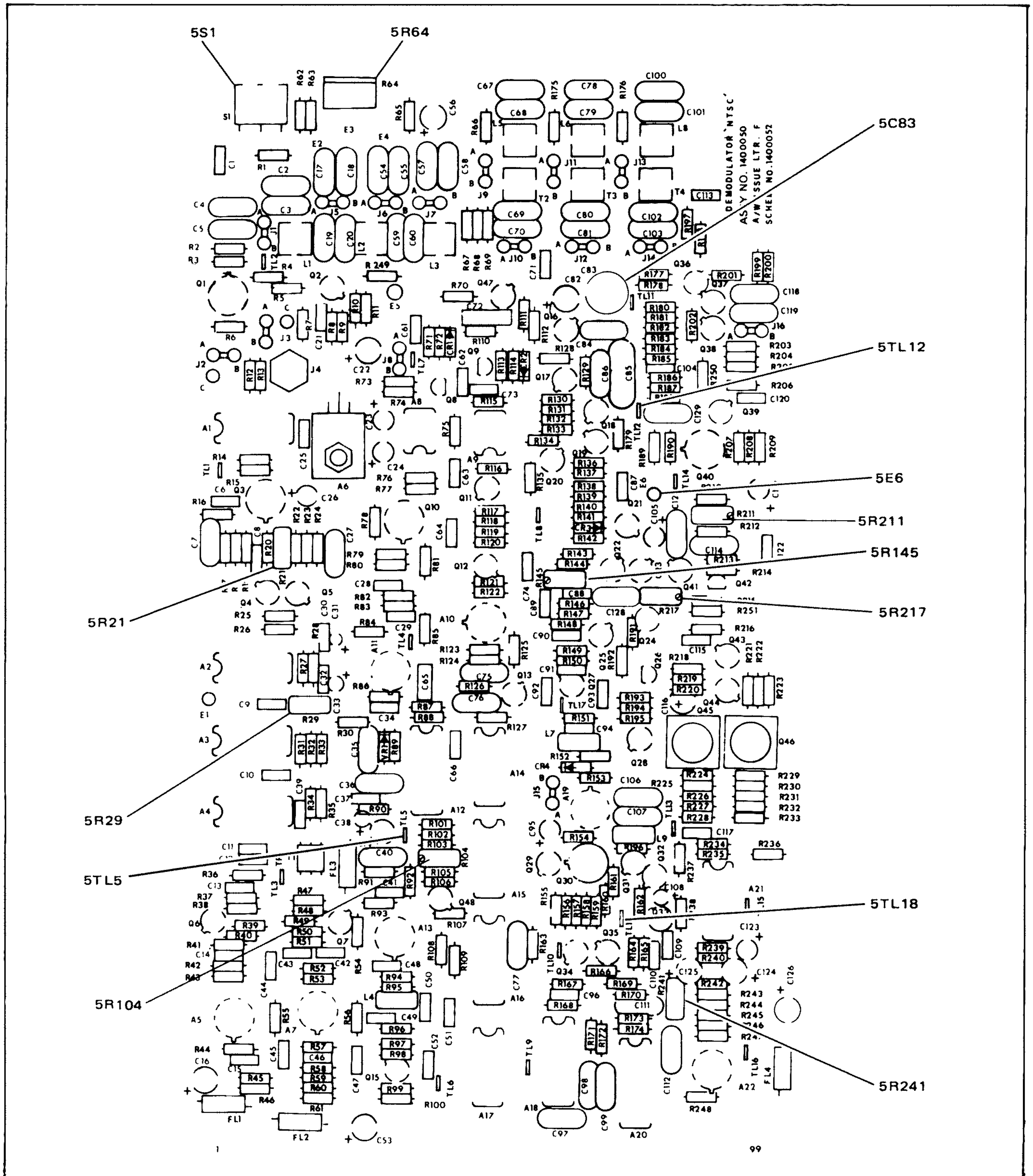


Figure 3-61. Demodulator PWA 5 (NTSC), Assembly No. 1400050

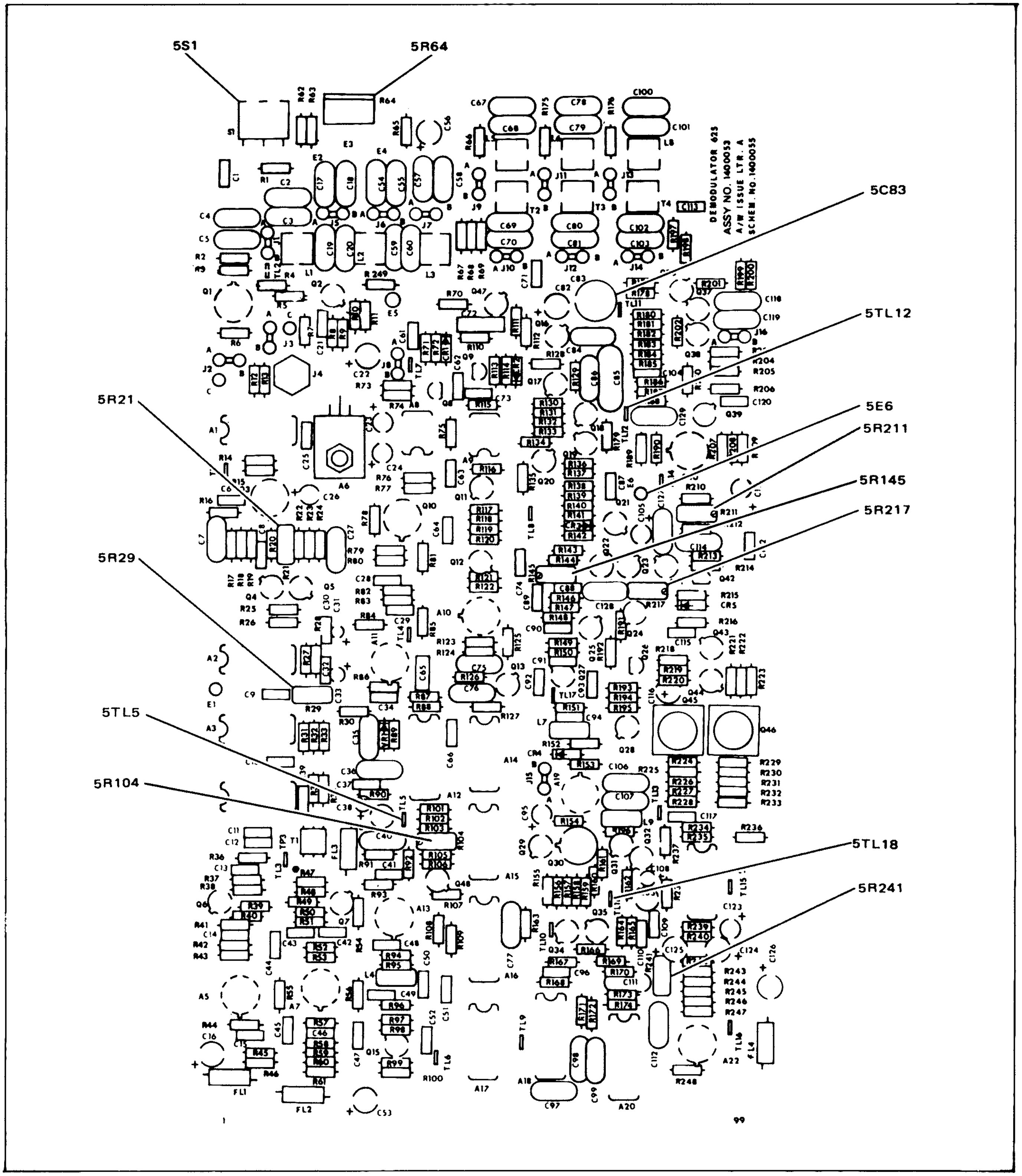


Figure 3-62. Demodulator PWA 5 (625), Assembly No. 1400053

9. Adjust burst phase:

   a. Connect vectorscope to PWA 5 pins 79/80 (VIDEO 1 OUT).

   b. Set dip switch 14S2-4 to SECAM (closed [+]) position.

   c. Set up vectorscope for normal display.

   d. Set switch 14S2-4 to NTSC/PAL (open) position.

   e. Adjust variable capacitor 5C131 for normal display as in step 9c.

10. Repeat steps 8, 9b, and 9c until vectorscope display is normal and burst amplitude is equal to sync amplitude.

11. Adjust burst X 2/÷2 amplitude:

   a. Set switch 14S4 position 4 to SECAM (closed) position.

   b. Connect scope probe to test lug 5TL18.

   c. Adjust 5R145 for a burst envelope amplitude of 7.5 Vp-p.

   d. Set 14S4 position 4 to the required standard (open for an NTSC or PAL system; closed for a SECAM system).

12. Adjust AUTO CHROMA ERROR level:

   a. Set CHROMA LEVEL switch on Equalizer PWA 4 (front edge) to AUTO position.

   b. Connect scope probe to PWA 5 pin 75 (AUTO CHROMA ERROR).

   c. Adjust 5R241 for zero error volts observed on scope.

13. Moiré optimization:

   a. Connect moiré test signal to VIDEO IN connector.

   b. Connect spectrum analyzer probe to PWA 5 pins 79/80 (VIDEO 1 OUT).

   c. Adjust DETECTOR BALANCE potentiometer 5R21 and LIMITER BALANCE potentiometer 5R29 for a null at 4.9 MHz (minimum moiré).

   d. Verify that:

      (1) The 4.9 MHz level is 60 dB or greater below the 3.58 MHz level.

      (2) The 2.8 MHz level is 38 dB or greater below the 3.58 MHz level.

      (3) All other frequencies from 1 MHz to 3.58 MHz, and from 3.58 MHz to 10 MHz are 40 dB or greater below the 3.58 MHz level.

14. Verify playback moiré .

   a. Connect a moiré test signal to the VIDEO IN connector.

   b. Connect spectrum analyzer to the VIDEO 1 OUT connector.

   c. Make a two-minute recording of the moiré test signal.

   d. Rewind the tape, enter play mode, and verify that the moiré components are 40 dB (36 dB) below the 3.58 MHz (4.43 MHz) reference. (If necessary, detector balance control 5R29 may be adjusted for minimum moiré.

15. Dropout sensitivity adjustment.

   a. Remove power and withdraw Equalizer PWA 4. Place AGC INHIBIT jumper 4J8 (625) or 4J7 (525) in A–C (AGC INHIBIT) position. Replace Equalizer PWA into slot 4 and restore power.

   b. Perform paragraph 3-70 steps 1 through 5 to optimize the video record head current.

c. Connect scope probe 1 to PWA 5 pins 21/22 (D.O. RF IN). Trigger scope from PWA 14 TP2 (front edge).

d. Play back the recording made during step 15b above; log the rf level observed on the scope.

e. Perform step 15b above to optimize the video record head current; while doing so, adjust record level potentiometer 6R1 such that the level observed at PWA 5 pins 21/22 is 16 dB down from the level logged in step 15e above (1/6th of the amplitude).

f. Connect scope probe 2 to test lug 5TL5.

g. Adjust 5R104 such that dropouts occur at 5TL5.

16. Remove power and extract Equalizer PWA 4; set jumper 4J8 (625) or 4J7 (525) to position A–B (Normal – AGC). Return PWA to slot 4.

17. Remove PWA 5/extender, separate and return PWA to slot 5. Restore power.

3-72. Equalizer PWA 4 Adjustment. Refer to Figures 3-63 and 3-64 for component locations while performing the procedure below.

1. Remove power and withdraw Equalizer PWA from slot 4; place PWA on extender and insert extender/PWA into slot 4.

2. Set VPR front panel switches:

   a. Set VIDEO RECORD ENABLE switch to ENABLE (up).

   b. Set SYNC RECORD ENABLE switch to ENABLE (up).

   c. Set EDITOR switch to OFF position.

3. Connect television signal generator to VIDEO IN connector (rear panel). Set generator controls to provide a multiburst signal.

4. Initiate record mode and make a 5 to 10 minute recording.

5. Proceed as follows:

   a. Connect scope to VIDEO 1 OUTPUT connector; trigger from internal.

   b. Set CHROMA SELECT switch to MANUAL position (down).

   c. Set CHROMA UNITY/VAR switch (5S1 Demodulator PWA front edge) to UNITY position.

6. Set VIDEO EQUALIZER potentiometer 4R129 to fully clockwise position.

7. Initiate playback of the recording made in step 4 above. Proceed as follows:

   a. Adjust potentiometer 4R192 such that the playback signal just begins to break up (to become over-equalized).

   b. Set 4R129 (VIDEO EQUALIZER) to mid-range position and adjust EQUALIZER CENTERING potentiometer 4R65 (NTSC-sync) or 4R64 (NTSC-non sync) for a flat frequency response as observed on scope (the 4.2-MHz burst and 1-MHz burst are of equal amplitude).

   c. Initiate shuttle mode and set slow motion/shuttle knob to fully clockwise position.

   d. Adjust SHUTTLE ADJUST potentiometer 4R134 (or 4R127 NTSC non-sync) such that the playback signal in shuttle stop mode displays a flat frequency response.

8. Set signal generator controls to provide modulated stairs or ramp to the VIDEO IN connector.

9. Initiate record mode and make a 5 or 10 minute recording. Terminate recording.

10. Connect vectorscope and scope (or waveform monitor) to VIDEO 1 OUTPUT connector.

11. Initiate playback of recording just made and:

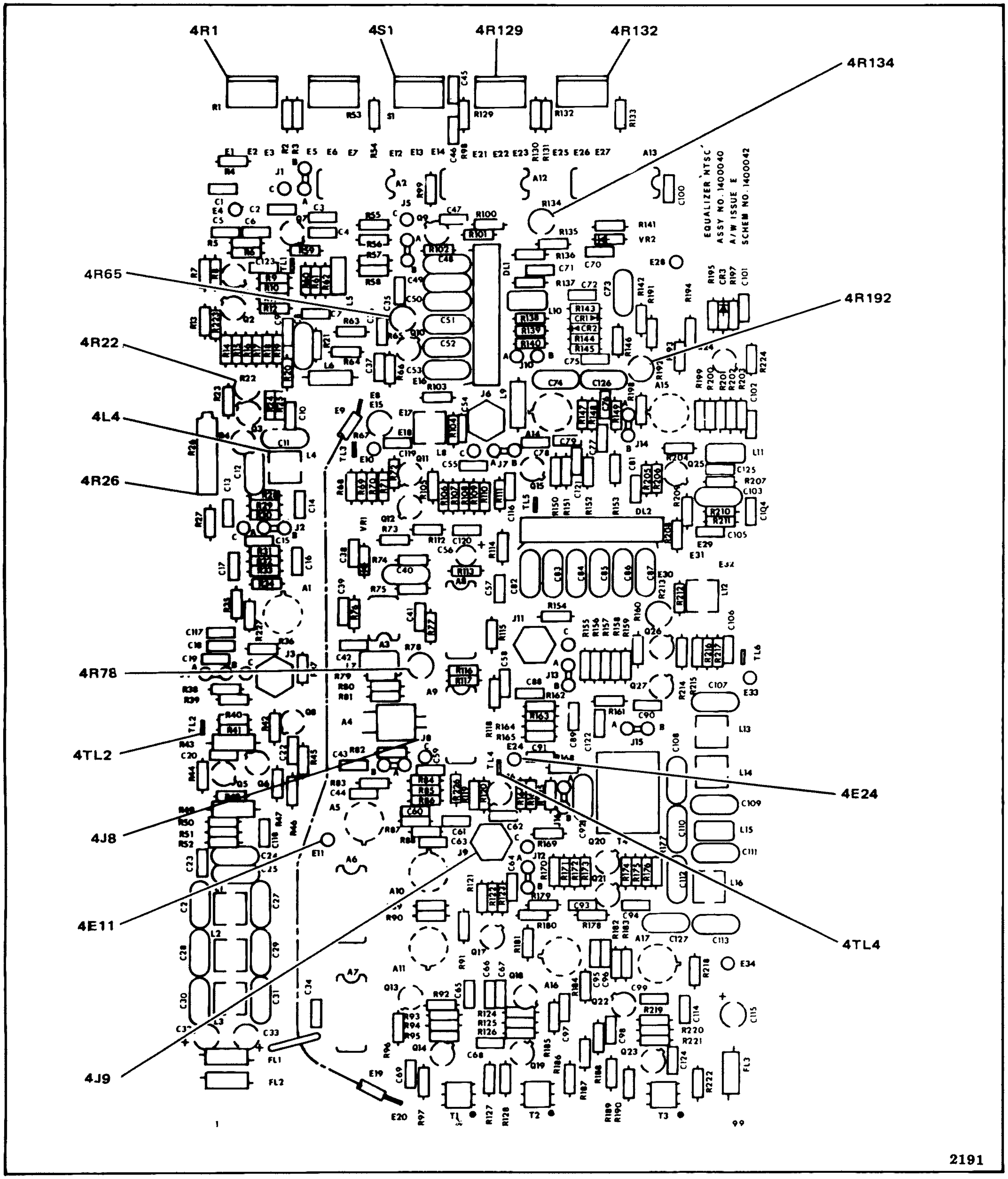


Figure 3-63. Equalizer PWA 4 (NTSC), Assembly No. 1401040

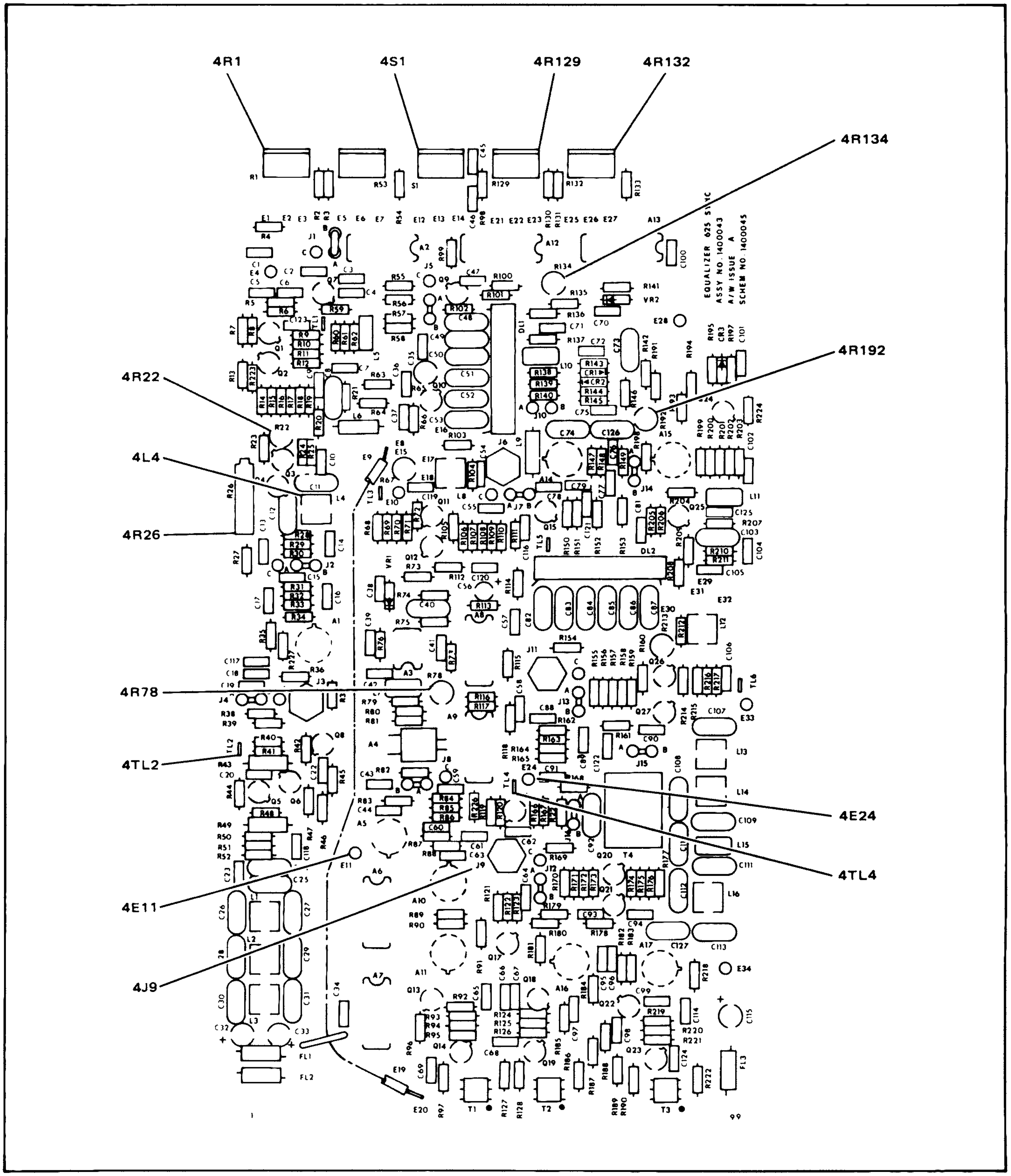


Figure 3-64. Equalizer Sync PWA 4 (625), Assembly No. 1400043

a. Adjust VIDEO D.G. potentiometer 4R1 (PWA front edge) for best differential gain (4% or better).

b. Set DIFF PHASE ADJ potentiometer 4R26 to midrange position.

c. Adjust CENTER FREQUENCY ADJUST variable inductor 4L4 for best differential phase.

d. Adjust DIFF PHASE ADJ 4R26 for best differential phase; should be 4° or better.

12. Repeat steps 7b and 11a until no further interaction occurs.

NOTE

This adjustment procedure is easier to do and provides more accurate results if VITS (vertical interval test signal) is recorded in the vertical interval.

13. Perform sync equalization (for non-sync equipped systems, disregard this step):

a. Initiate playback of recording made above.

b. While playing back, adjust SYNC EQUALizer ADJ potentiometer 4R132 (PWA front edge) for burst amplitude to be equal to sync amplitude during the vertical interval.

c. Adjust SYNC D.G. potentiometer 4R53 (PWA front edge) for best differential gain during the vertical interval; should be 4% or better.

14. Auto chroma calibration.

a. Remove power and extract Equalizer PWA/extender; separate the two and restore Equalizer PWA to slot 4. Extract Demodulator PWA/extender into slot 5 and restore power.

b. Initiate playback of recording made above.

c. Set CHROMA AUTO/MANUAL switch (Equalizer PWA 4 front edge) to AUTO position (up).

d. Set CHROMA UNITY/VAR switch (Demodulator PWA front edge) to UNITY position (up).

e. Adjust potentiometer 5R241 such that the burst amplitude is equal to the sync amplitude. (Note: Set for flat frequency response.)

f. Set CHROMA AUTO/MANUAL switch (Equalizer PWA front edge) to MANUAL position.

g. Adjust CHROMA LEVEL potentiometer 5R64 such that the burst amplitude is equal to the sync amplitude. (Note: Set for flat frequency response.)

15. Equalizer gain adjustment.

a. Remove power and extract Demodulator PWA/extender from slot 5. Separate the two and restore PWA to slot 5. Withdraw Equalizer PWA from slot 4 and place it on the extender. Insert PWA/ extender into slot 4. Connect scope probe channel 1 to test lug 4TL4. Trigger scope on internal. Turn VPR power on.

b. Set VIDEO RECORD ENABLE switch to ENABLE position.

c. Set signal generator controls to provide flat fixed video to the VPR VIDEO IN connector.

d. Initiate record mode.

e. For AST equipped systems, adjust VIDEO REC, LEVEL potentiometer 6R1 for 200 mVp-p on scope (for non-AST systems, proceed to step 16f below).

f. For non-AST equipped systems 6R1 must be adjusted during record to produce 200 mVp-p on the scope during playback. Initiate record and adjust 6R1. Enter playback to verify level (200 mVp-p) is correct. Repeat as required.

16. Set AGC INHIBIT jumper 4J8 to A–C position (AGC inhibit).

17. Connect scope channel 2 to test lug 4TL2.

18. Initiate play mode and adjust 4R22 for a signal amplitude of 300 mVp-p observed on scope. Set jumper 4J8 (625) or 4J7 (525 non sync) to A–B position (Normal – AGC).

19. While in play mode, adjust AGC ADJ potentiometer 4R78 for a signal amplitude of 300 mVp-p observed on scope.

20. Perform paragraph 3-70 steps 1 through 6, to optimize the video and sync record head currents.

3-73. Editor Functional Checks. Check the various editor functions using the procedure below. Read each step completely before executing. VPR must be fully checked out up to this point in order for the following checks to be valid.

3-74. Preliminary.

1. Connect a television test signal generator to the VIDEO IN connector. Connect VIDEO 1 OUT to a video monitor via the time-base corrector.

2. Set signal generator controls to provide full field color bars.

3. Thread a reel of bulk-erased tape on the transport.

4. Set VPR controls:

CONTROL	SETTING
TAPE/EE	EE
RECORD LEVEL POT's	pushed in
EDITOR	OFF
AUTO EDIT	OFF
VIDEO REC	ON
AUDIO 1 REC	ON
AUDIO 2 REC	ON
AUDIO 3 REC	ON
Search PWA, slot 18	
PREROLL switch	OFF

3-75. Audio Record Command Time Constant Check.

1. Remove VPR power. Extract Control PWA, place it on an extender, replace PWA/extender in slot 17.

2. Set Control PWA RECORD LOCKOUT switch to OFF (down).

3. Connect scope channel one probe to component A54 pin 9 (Figure 3-65).

4. Set VPR EDITOR switch to INSERT.

5. Restore VPR power.

6. Place VPR in record mode. Turn AUDIO 1 REC enable switch on and off several times. Observe that toggling the switch produces a negative-going pulse on the scope (A54-9).

7. While toggling the switch, adjust potentiometer 17R1 (one-shot time out adjust) for 19 ms (525 standard) or 13 ms (625 standard) observed on scope (negative trigger in NORMAL mode).

8. Remove VPR power. Extract PWA/extender, separate the two, and restore Control PWA to slot 17. Restore VPR power.

9. Set VPR INSERT/OFF/ASSEMBLE switch to OFF.

3-76. Manual Edit.

1. Set RECORD LOCKOUT switch on Control PWA 17 to on (up). Note that the front panel RECORD LOCKOUT indicator lights.

2. Attempt to place machine in record mode. Verify that it does not enter record mode.

3. Set Control PWA RECORD LOCKOUT switch 17S1 (Figure 3-65 to off (down). Note that RECORD LOCKOUT indicator goes off.

4. Set VIDEO, AUDIO 1, AUDIO 2, and AUDIO 3 (and AUDIO 4 if so equipped) record enable switches to off (down). Verify that RECORD LOCKOUT indicator lights.

5. Attempt to place machine in record mode – verify that it does *not* enter record. Verify that machine enters play mode.

6. Set EDITOR switch to INSERT. Verify that RECORD LOCKOUT indicator blinks.

7. Set EDITOR switch to ASSEMBLE. Verify that RECORD LOCKOUT indicator blinks.

8. Set EDITOR switch to OFF.

9. Momentarily turn the VIDEO. AUDIO 1, AUDIO 2, AUDIO 3 (and AUDIO 4 if so equipped), switches off one at a time. Verify that RECORD LOCKOUT INDICATOR blinks while each switch is off (begin by turning all switches ON).

10. Set VIDEO, AUDIO 1, AUDIO 2, AUDIO 3, (and AUDIO 4 if so equipped) record enable switches to ON.

11. Shuttle VPR to a clean (nonrecorded) portion of tape.

12. Set Search PWA PRE-ROLL switch to OFF. Press front panel RESET and ENTRANCE buttons.

13. Make a 5-minute recording to full-field color bars input to video with no input to audio channels.

14. Press SEARCH button. Note that VPR rewinds to entrance point and tape timer display reads 00:00:00:00.

15. Set EDITOR switch to INSERT.

16. Set signal generator controls for split field.

17. Connect a 1-kHz audio signal source of +8 dBm amplitude to AUDIO 1, AUDIO 2, AUDIO 3, and (if applicable) AUDIO 4 inputs.

18. Set all VIDEO/AUDIO record enable switches to off.

19. Record 5-second segments. Read this step completely before proceeding. The timing specified below may be changed to suit the operator (observe tape timer display). Initiate record. Press and hold RECORD button down and press PLAY button. Proceed as follows:

    a. Verify that RECORD and PLAY buttons light and that VTR enters play mode.

    b. Verify that as each RECORD ENABLE switch is turned on (below) the PLAY button goes out and the RECORD button lights (VTR enters record mode).

    c. Turn VIDEO RECORD ENABLE switch on from 5 to 10 seconds.

    d. Turn AUDIO 1 RECORD ENABLE switch on from 15 to 20 seconds.

    e. Turn AUDIO 2 RECORD ENABLE on from 25 to 30 seconds.

    f. Turn AUDIO 3 RECORD ENABLE on from 35 to 40 seconds.

    g. If EBU AUDIO 4 configured, turn AUDIO 4 RECORD ENABLE on from 45 to 50 seconds.

20. Press SEARCH button. Verify VTR rewinds until tape timer display reads 00:00:00:00.

21. Play recorded segments. Verify no pops or clicks are heard on audio segments (use audio monitor):

    a. Set TAPE/EE switch to TAPE.

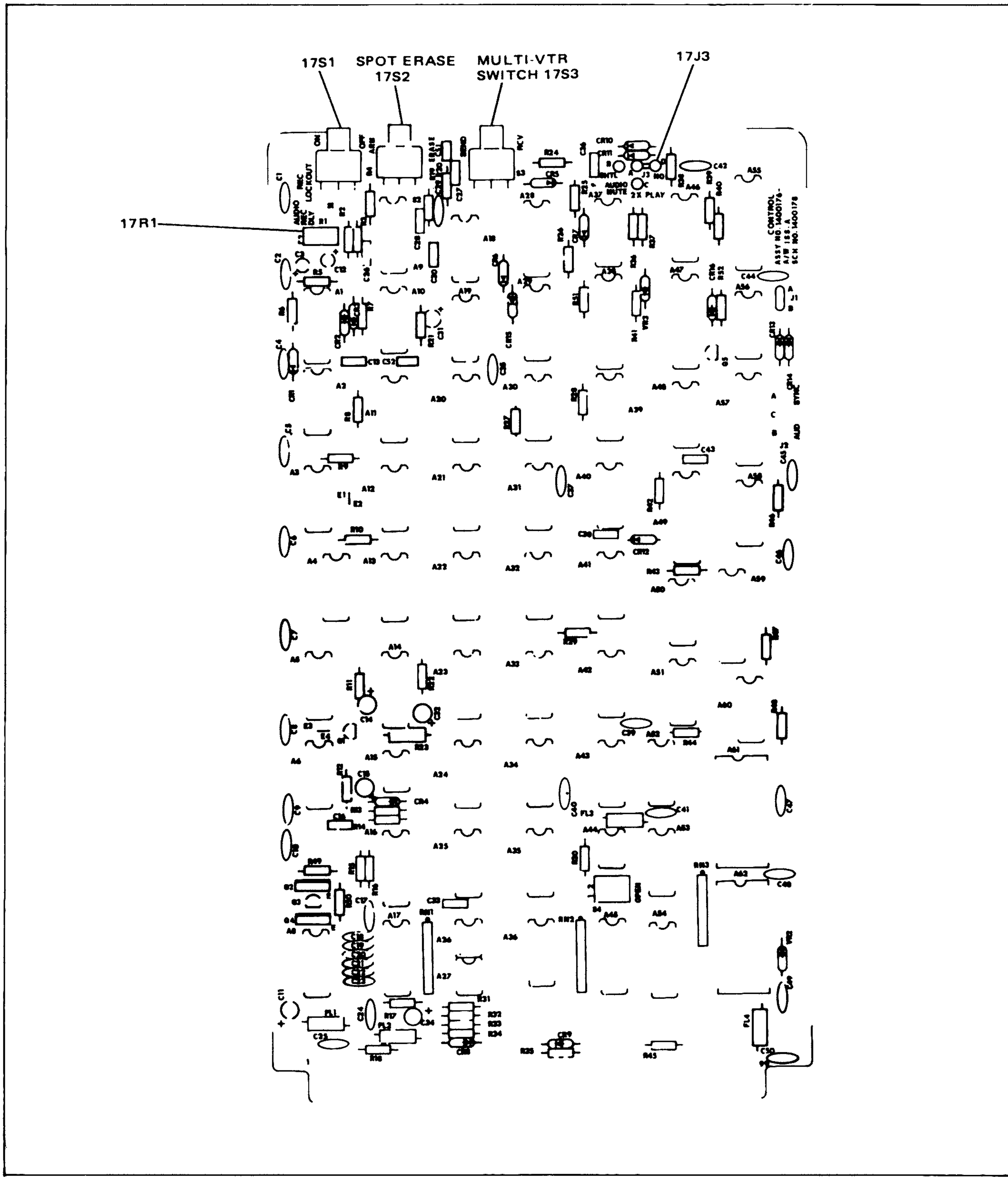


Figure 3-65. Control PWA 17, Assembly No. 1400176

b. Press PLAY button to enter play mode.

c. Monitor all recorded segments. Verify video edit is clean at entrance and exit points. Verify audio sounds clean, especially at entrance and exit points.

22. Shuttle machine to a clean (unrecorded) portion of tape.

23. Press RESET and ENTRANCE to establish entrance point.

24. Verify EDITOR switch is in INSERT, and set VIDEO; AUDIO 1, AUDIO 2, AUDIO 3 (and AUDIO 4 if applicable) to on.

25. Place VTR in play. After servos lock up (SERVO indicator out), perform the following:

    a. Place VTR in record.

    b. After 5 seconds of record mode, press and hold PLAY button and tap STOP button.

    c. Verify that record mode terminates and machine continues in play (RECORD lamp out, PLAY lamp on).

26. Press SEARCH button. Verify that VTR rewinds until display reads 00:00:00:00.

27. Place VTR in play mode. Verify that video and audio edits are clean at both the entrance and exit points.

28. Shuttle machine to a clean (unrecorded) portion of tape.

29. Press RESET and ENTRANCE buttons to establish entrance point.

30. Set EDITOR switch to ASSEMBLY, and VIDEO, AUDIO 1, AUDIO 2, AUDIO 3 (and AUDIO 4 if applicable) RECORD ENABLE switches to off.

31. Record a 5-second segment. Read through this step before beginning:

    a. Place VTR in record mode.

    b. Turn VIDEO RECORD ENABLE switch on from 5 to 10 seconds.

    c. Verify that while switch is on, the PLAY button goes out and RECORD button lights (VTR enters record mode).

32. Press SEARCH button. Verify that VTR rewinds until display reads 00:00:00:00.

33. Place VTR in play mode. Verify video playback is present and that it is clean at the entrance point (only).

3-77. Auto Edit.

1. With power removed, extract Tape Timer PWA 19, mate it to an extender, and reinsert PWA/extender into slot 19. Restore power.

2. Shuttle machine to a clean (unrecorded) portion of tape that is at least 20 seconds past the manual edit portion (done in the previous check).

3. Set various switches:

    a. AUTO EDIT switch to ON.

    b. EDITOR switch to INSERT.

    c. TAPE/EE switch to TAPE.

    d. VIDEO, AUDIO 1, AUDIO 2, AUDIO 3, (and AUDIO 4 if applicable) RECORD ENABLE switches to on.

    e. On Search PWA, set PREROLL switch to PREROLL 1 (up).

4. Set up edit:

    a. Press RESET and ENTRANCE buttons.

    b. Manually move tape forward two frames — display reads 00:00:00:02.

    c. Press EXIT.

d. Manually move tape backward six frames.

e. Manually move tape forward and verify that edit INTERVAL indicator lights at 00:00:00:00 on display.

f. Continue moving tape forward and verify that edit INTERVAL goes out at 00:00:00:02 on display.

3-78. Rehearse Edit.

1. Press SEARCH button and verify that tape rewinds until display reads 23:59:55:00 (23:59:53:00 PAL).

2. Set TAPE/EE switch to EE.

3. Place VTR in play mode and verify that:

   a. Video flashes (appears) on the monitor during the edit interval.

   b. A burst of audio occurs during the edit interval.

4. Press SEARCH button and verify that tape rewinds until display reads 23:59:55:00 (23:59:53:00 PAL).

5. Set TAPE/EE switch to TAPE and AUTO EDIT to OFF.

6. Place VTR in play and verify that no edit took place (video or audio).

3-79. Auto Insert Edit.

1. Press SEARCH button to rewind tape.

2. Set TAPE/EE switch to TAPE. AUTO EDIT to ON.

3. Initiate record mode and verify that:

   a. RECORD and PLAY buttons light.

   b. VTR enters play mode.

   c. PLAY button indicator goes out during edit interval. Note that this two-frame edit is quick. Repeat steps 1 through 3 if necessary to see edit action.

4. Press SEARCH to rewind tape.

3-80. Verify Auto Insert Edit.

1. Set up storage scope (see Table 5-1 for model number):

   a. Connect video out of VPR (demodulated video) to storage scope channel 1 input.

   b. Connect VPR AUDIO 1 output to storage scope channel 2 input.

   c. Set scope controls:

Horizontal Time Base	10	ms/div
Channel 1 Vertical Sensitivity	1	volt/div
Channel 2 Vertical Sensitivity	5	volts/div

   Remove VPR power and place Tape Timer PWA on the extender. Connect scope external trigger jack to pin 28, REMOTE EDIT INTERVAL. Trigger from negative slope. Restore VPR power.

2. Place machine in play mode. Verify that VIDEO and AUDIO 1 edit entrance point occurs ± 1 field of edit entrance point (trigger point).

3. Press SEARCH button to cue tape.

4. Manually advance the tape past the edit interval and verify that the VIDEO/AUDIO 1 edit exists on frames 0 and 1 only.

5. Disconnect VIDEO 1 and AUDIO 1 from storage scope and connect AUDIO 2 and AUDIO 3 to scope channel 1/channel 2 input respectively.

6. Place machine in play mode. Verify that AUDIO 2/AUDIO 3 edit entrance points occur ± 1 field of edit entrance point (trigger point).

7. Press SEARCH button to cue tape.

8. Manually advance tape past the edit interval and verify that the AUDIO 2/AUDIO 3 edit exists on frames 0 and 1 only.

9. If EBU Audio 4 equipped, perform the following:

   a. Disconnect AUDIO 3 from scope and connect AUDIO 4 to scope channel 2.

   b. Place machine in play mode. Verify AUDIO 4 entrance point occurs ± 1 field of edit entrance point (trigger point).

   c. Press SEARCH button to cue tape.

   d. Manually advance tape past edit interval and verify AUDIO 4 edit exists on frames 0 and 1 only.

3-81. Auto Assemble Edit.

1. Shuttle VTR to a clean (unrecorded) portion of tape – at least 20 seconds past the auto insert edit done previously.

2. Press RESET and ENTRANCE buttons to establish entrance point.

3. Set EDITOR switch to ASSEMBLE position.

3-82. Rehearse Assemble Edit.

1. Press SEARCH button to cue tape. Verify that tape rewinds until tape timer display reads 23:59:55:00 (23:59:53:00 PAL).

2. Set TAPE/EE switch to EE.

3. Observe edit on video/audio monitors:

   a. Place machine in play mode.

   b. Verify that video appears and audio tone comes on at edit interval entrance.

4. Press SEARCH button – verify that tape rewinds until tape timer display reads 23:59:55:00 (23:51:53:00 PAL).

5. Set TAPE/EE switch to TAPE and AUTO EDIT switch to OFF.

6. Perform the following:

   a. Place machine in play mode.

   b. Verify that the edit did not take place.

3-83. Auto Assemble Edit.

1. Press SEARCH button to cue tape.

2. Set AUTO EDIT to ON and set TAPE/EE switch to TAPE.

3. Create auto assemble edit:

   a. Initiate record mode.

   b. Verify that PLAY and RECORD button indicators light and VTR enters play mode.

   c. Verify that PLAY button indicator goes out during edit interval.

   d. Allow edit to run about 5 seconds.

   e. Press SEARCH to terminate edit and cue tape (edit will continue unless terminated).

3-84. Verify Auto Assemble Edit.

1. Place machine in play.

2. Verify edit is clean at the entrance point.

3. Remove VPR power. Extract Tape Timer PWA/extender from slot 19, separate the two, and reinsert Tape Timer PWA into slot 19.

3-85. Multi-VTR Edit. This procedure is used to check the multi-VTR edit features of VPR.

1. With power removed, extract Control PWA from slot 17, mate it to the extender, and reinsert PWA/extender into slot 17. Restore power.

2. Set AUTO EDIT switch to ON.

3. Set EDITOR switch to INSERT.

4. Verify existence of EDIT SEND signal:

   a. Enter READY mode and press SEARCH BUTTON.

   b. After VTR has cued, connect scope probe to Control PWA pin 57.

   c. Press PLAY button and verify that a momentary negative-going TTL pulse occurs at pin 57.

5. Set EDITOR switch to OFF position.

6. Set AUTO EDIT switch to OFF position.

7. With power removed, extract Control PWA/extender from slot 17, separate the two, and reinsert Control PWA into slot 17. Restore power.

3-86. Video Record Optimization. Perform the video head and/or sync head optimization procedure whenever a video record head or sync record head has been changed, or a different type of video tape is used. The procedure should also be performed periodically as the heads wear down.

3-87. *Video Head Record Optimization.* Use the following procedure to optimize the video record head on an AST or non-AST system.

1. Thread tape of the type to be optimized onto the VPR.

2. Place system into normal record mode.

3. Set 6R1 (VIDEO REC LEV) on front edge of Modulator PWA 6 to maximum counterclockwise position. Then slowly turn 6R1 clockwise while watching the RF LEVEL meter. As 6R1 is turned clockwise, the meter will reach a peak meter reading and then start to decline. Set 6R1 to the minimum level (farthest counterclockwise position) that produces a peak reading on the meter.

3-88. *Sync Head Record Optimization.* Use the following procedure to optimize the sync record head.

1. Thread tape of the type to be optimized onto the VPR.

2. Place system into normal record mode.

3. Set 6R65 (SYNC REC LEVEL) on front edge of Modulator PWA 6 to maximum counterclockwise position.

4. Press VIDEO RF switch to the SYNC RF position while slowly turning 6R65 clockwise and observing RF LEVEL meter. As 6R65 is turned clockwise, the meter will reach a peak meter reading and then start to decline. Set 6R65 to the minimum level (farthest counterclockwise position) that produces a peak reading on the meter.

3-89. RF LEVEL Meter Calibration

Recalibrate the RF LEVEL meter reading whenever a play head (AST or non-AST, record head, or sync head is changed.

3-90. Preliminary Procedure. Proceed as follows:

1. Thread tape onto the VPR.

2. Make a short test recording and rewind the tape.

3-91. Play Head RF LEVEL Meter Calibration. Proceed as follows:

1. With power off, remove Playback Sync Processor PWA 8 from the electronics assembly, place on an extender board, and reinstall into electronics assembly.

2. Apply power and enter standby mode with the scanner not running.

3. On AST systems only, place AST ON/OFF switch 9S1 to OFF position.

4. Adjust play head METER ZERO 8R47 (Figure 3-53) for zero indication on the RF LEVEL meter.

5. While playing back the test recording made in the *Preliminary Procedure* (paragraph 3-90)

set tracking switch to VARiable (down) and adjust the VAR TRACKING control for peak reading on the RF LEVEL meter and then adjust PLAY RF METER CAL 8R71 for desired meter level indication (suggest between 2/3 and 3/4 meter-scale indication). Note this reading.

3-92. Record Head Playback RF LEVEL Meter Calibration.

1. Set EDITOR switch to INSERT.

2. With VPR in standby mode and drum not running, adjust RECORD HD METER ZERO (8R80) for zero indication on the RF LEVEL meter.

3. While playing back the recording made in the *Preliminary Procedure* (paragraph 5-90), adjust the VAR TRACKING control for peak reading on the RF LEVEL meter and then adjust RECORD HD METER CAL 8R72 for the same reading as set in paragraph 5-91, step 5.

4. Set EDITOR switch to OFF.

3-93. Sync Head Playback RF LEVEL Meter Calibration. For all adjustments in this procedure, hold VIDEO RF switch in the SYNC RF position. Proceed as follows:

1. With the VPR in standby mode and drum not running, hold meter switch to SYNC RF position and adjust SYNC METER ZERO 8R93 for zero indication on the RF LEVEL meter.

2. While playing back the test recording made in the *Preliminary Procedure* (paragraph 3-90), hold switch to SYNC RF and adjust the VAR TRACKING control for peak reading on the RF LEVEL meter and then adjust SYNC METER CAL 8R91 for the same reading as set in paragraph 3-91, step 5 (Figure 3-46).

3. Return tracking switch to UNITY, remove power, remove extender board, and reinstall Playback Sync Processor PWA 8 into electronics assembly.

3-94. Audio Signal System

The audio check and alignment procedures which follow pertain to both SMPTE and EBU version systems having audio channels 1, 2, and 3/4. Procedures for the optional EBU Audio 4 PWA begin at paragraph 3-113.

The following paragraphs contain test and alignment procedures for ensuring proper operation of the audio signal system. The test procedures may be used to check overall audio system performance. If the tests are satisfactory, then the alignment procedures need not be performed.

NOTE

These procedures have been performed at the factory and need be repeated only when a repaired or replacement PWA or head assembly has been installed into the recorder. The record bias alignment procedure (only) must be performed when the type of tape used is changed.

After the audio alignment procedures have been performed, repeat the audio system check procedures to verify correct performance.

The VPR input and output levels are factory adjusted to an operating level of +8 dBm (0 vu on the audio level meters) and are recorded on the tape with a 1-kHz signal recorded at a flux level of 100 nWb/m.

The alignment procedures are presented step by step in serial form for alignment of one channel. After the reader has become familiar with the procedures, it may be more convenient to perform the steps in parallel for more than one channel. Also note that because of the capacitive effect of the extender board traces, the extender board is not used while making some adjustments. These adjustments are made on a "trial and error" basis.

Prior to performing the audio signal system alignment procedures, clean and demagnetize the head and other tape path components as described in the *Preventive Maintenance* section of this manual. The capstan servo, scanner servo, and control track systems must be operating properly. Tape tension values must be correct.

CAUTION

TO PREVENT POSSIBLE HEAD MAGNETIZATION OR ELECTRICAL COMPONENT DAMAGE, TURN POWER OFF BEFORE REMOVING OR INSTALLING A PRINTED WIRING ASSEMBLY (PWA) INTO VPR.

3-95. Audio System Checks. Perform the following audio system checks: Playback level and frequency response calibration, overall audio frequency response, harmonic distortion, audio erasure, and audio signal-to-noise ratio.

3-96. Playback Level and Frequency Response Check. This procedure provides an overall system operation check. Use it to assess audio system operation. Procedures to be used following a repair or PWA replacement may be found following this one.

This procedure is performed with the aid of an audio alignment tape. The tape is recorded with a series of tones, each tone persisting from 10 seconds to 1 minute (tones selected by ANSI Institute). The tape is introduced by voice announcement, and each tone is announced as well. A speaker or headphones (speaker is standard with console models) must be used to identify tones. Track widths on the tape are much wider than those of normal VPR-recorded audio tracks. The excessive track width causes excessive signal from the guard band (called fringing data) to be picked up by the head(s). Increasing tone frequency decreases fringing such that, at 10 kHz, no fringing exists. The fringing data value is unique to each tape and is included with each alignment tape.

CAUTION

DO NOT PROCEED IF THE ENTIRE TAPE PATH HAS NOT BEEN CLEANED AND DEGAUSSED. TO DO SO MAY DEGRADE THE AUDIO ALIGNMENT TAPE.

NOTE

All readings are taken with a 600-ohm resistor across the audio voltmeter input terminals.

1. Load the appropriate SMPTE or EBU audio frequency response and playback level alignment tape onto VPR (see Table 3-1 for Ampex Part Number.) Note the fringing correction factors specified for this tape.

2. Set controls and make connections:

   a. Set all UNITY/PLAYBACK switches S1, S2, S3 (AUDIO 1, 2, 3/4 respectively) to UNITY position (Audio PWA front edge).

   b. Set all front panel audio record enable switches to off (down) position.

   c. Connect an audio voltmeter to the audio output connector corresponding to the channel being aligned. This procedure is written for channel 1. The user will follow up by aligning channels 2, 3, and (if applicable) 4 in the same manner.

   d. Connect a 600-ohm, 1-watt resistor across the audio voltmeter input terminals; an external speaker/amplifier may also be connected to the terminals to permit voice announcements to be monitored.

   e. Set REC LOCKOUT on front edge of PWA 17 (control) to ON position (up). Verify that RECORD LOCKOUT LED lights.

3. Initiate PLAY mode and verify the following:

   a. While playing back the 1 kHz operational level tone, verify that the voltmeter reads +8.0 dBm (plus fringing data value listed on or with the test tape) or facility standard audio level (plus fringing data).

   b. With step 3a satisfied, verify that the vu meter (VPR front panel) reads approximately o vu.

   c. With 10 kHz tone playing, verify that the voltmeter reads +8.0 dBm ±0.25 dBm or facility standard.

d. Play portions of the tape producing tones ranging from 63 Hz to 16 kHz. Verify that the frequency response through the entire frequency range is within ±2.0 dB of the step 3c value.

e. Repeat steps 3a through 3d for the remaining audio channels. Change output connections as required.

3-97. Overall Audio Frequency Response. Check AUDIO 1, AUDIO 2, and AUDIO 3 frequency response.

1. Connect an audio oscillator to the AUDIO 1 INPUT connector.
2. Set oscillator frequency to 1.0 kHz and adjust oscillator output level to 0 dBm at VPR input.
3. Connect ac voltmeter to AUDIO 1 OUTPUT connector.
4. Connect 600-ohm 1-watt resistor across ac voltmeter terminals.
5. Thread a reel of bulk erased tape onto the transport.
6. Set AUDIO 1 RECORD LEVEL switch/control to UNITY position (in).
7. Check unity gain: Apply power and set TAPE/EE switch to EE (enter EE mode) and verify that ac voltmeter indicates 0 dBm.
8. Set Control PWA RECORD LOCKOUT switch to OFF (down). Set AUDIO 1 RECORD ENABLE switch (control panel) to ON (up).
9. Make a short recording of the following frequencies while maintaining a 0 dBm input level for all frequencies: 50 Hz, 100 Hz, 500 Hz, 1.0 kHz, 5.0 kHz, 10.0 kHz, 12.0 kHz, and 15.0 kHz.
10. Rewind the tape, enter play mode, and check the playback level and response. The 1 kHz level should be 0.0 dBm ±0.5 dB. The response should be within the limits of ±2.0 dB from 50 Hz to 15.0 Hz as referenced to the 1.0 kHz level.
11. After verification of the playback level (0 dBm), check the operation of the front panel vu meter. Increase the audio oscillator output level to provide +8.0 dBm at 1 kHz. The vu meter should read 0 vu.
12. Repeat steps 1 through 7 for audio channels 2 and 3.

3-98. Audio Harmonic Distortion. It is recommended that harmonic wave levels be measured using a spectrum analyzer (the use of a total harmonic distortion analyzer to measure off-tape distortion is not recommended). The audio oscillator used for measurement should not have a residual second harmonic component greater than 0.03% rms (−70 dB) for fundamental frequencies from 500 Hz to 1.0 kHz. Also the third harmonic component should not be greater than 0.05% rms (−66 dB).

1. Connect an audio oscillator to the AUDIO 1 INPUT connector.
2. Set oscillator frequency to 1.0 kHz and adjust oscillator output level to +8 dBm.
3. Connect the input of the spectrum analyzer to the AUDIO 1 OUTPUT connector of the VPR.
4. Connect a 600-ohm resistor across the spectrum analyzer input terminals.
5. Set AUDIO 1 RECORD LEVEL switch/control to UNITY "in" position.
6. Set the spectrum analyzer controls as follows:

a. Amplitude Mode	10 dB/div
b. Amplitude Ref Level	Normal
c. Switch	dBm 600 ohms
d. Display	Reduced bandwidth
e. Resolution Bandwidth	100 Hz

f. Freq Span/Div 0.5 kHz

g. Switch Time/Div 1.0 Sec

h. Sweep Mode Rep

7. Apply power and set TAPE/EE switch to EE.

8. Adjust input sensitivity on spectrum analyzer so that the 1.0-kHz signal touches the top line of the scope graticule.

9. Make a 1-minute recording of the 1.0 kHz signal.

10. Rewind the tape and enter play mode.

11. Adjust spectrum analyzer to measure second harmonic content (2.0 kHz); this should be –50.0 dB or better.

12. Adjust spectrum analyzer to measure third harmonic content (3.0 kHz); this should be –41 dB or better.

13. Repeat all steps for audio channel 2. The specifications for channel 2 are the same as for channel 1. Repeat all steps for audio channel 3.

14. Check third harmonic content at +14 dBm peak operation level (or at 6 dB above operating level) as follows:

    a. Adjust oscillator output level for +14 dBm (or 6 dB above operating level) at 1 kHz.

    b. Make a 1-minute recording on channel 1 and then on channel 2. Repeat for channel 3.

    c. Rewind the tape and enter play mode.

    d. Third harmonic (3.0 kHz) content on channels 1, 2, and 3 should be –41 dB or better, with predistortion.

3-99. Audio Erasure. Audio erasure is measured by first making a recording at +14 dBm peak operating level (or 6 dB above operating level), and then erasing the tape while making a "no signal" recording. This "no signal" recording is then checked for residual signal using a spectrum analyzer. Proceed as follows:

1. Connect an audio oscillator to the AUDIO 1 INPUT connector.

2. Set oscillator frequency to 1.0 kHz and adjust oscillator output level to 14 dBm (or 6 dB above operating level).

3. Connect the input of the spectrum analyzer to the AUDIO 1 OUTPUT connector of the VPR.

4. Connect a 600-ohm resistor across the spectrum analyzer input terminals.

5. Set AUDIO 1 RECORD LEVEL switch/control to UNITY "in" position.

6. Set the spectrum analyzer controls as follows:

    a. Amplitude Mode 10 dB/div

    b. Amplitude Ref Level Normal

    c. Switch dBm 600 ohms

    d. Display Reduced bandwidth

    e. Resolution Bandwidth 100 Hz

    f. Freq Span/Div 0.5 kHz

    g. Sweep Time/Div 1.0 sec

    h. Sweep Mode Rep

7. Apply power and set TAPE/EE switch to EE.

8. Adjust input sensitivity on spectrum analyzer so that the 1.0-kHz signal touches the top line of the scope graticule.

9. Make a 1-minute recording of the 1.0-kHz signal.

10. Rewind the tape to the beginning of the recording.

11. Remove the oscillator and short all three pins of the AUDIO 1 INPUT connector together.

12. Enter record mode to erase the recording made in step 9.

13. Rewind the tape to the beginning of the recording made in step 9 and enter play mode.

14. Measure the residual signal content on the erased portion of the tape on the spectrum analyzer. Erased portion should be –70 dB or better.

15. Repeat steps 1 through 14 for channels 2 and 3. Erased portion should be –65 dB or better.

3-100. Audio Signal-to-Noise Ratio. Audio signal-to-noise ratio is measured referenced to a +14 dBm peak operating level (or 6 dB above operating level). Proceed as follows:

1. Thread a reel of bulk erased tape onto the transport.
2. Short all three pins of the AUDIO 1 INPUT connector together.
3. Connect an ac voltmeter to the AUDIO 1 OUTPUT connector.
4. Connect a 600-ohm 1-watt resistor across the ac voltmeter terminals.
5. Set audio 1 RECORD LEVEL switch/control to UNITY "in" position.
6. Enter record mode for 1 minute.
7. Rewind tape to beginning of recording and enter play mode. The playback signal should be –56 dB (or –42 dBm as read on the ac voltmeter) or greater for Audio 1 and 2; –50 dB (–36 dBm) or greater for Audio 3.
8. Repeat steps 2 through 6 for audio channels 2 and 3.
9. Check control track to Audio 3 crosstalk.

   a. Short all three pins of the AUDIO 3 INPUT connector.

   b. Connect scope probe to AUDIO 3 OUTPUT connector.

   c. Enter record mode for 30 seconds. Rewind, play back and observe scope. The control-track pulses present in the Audio 3 signal (crosstalk) should be 50 mVp-p or less.

3-101. Audio System Alignment Procedure

The following is a procedure for overall audio system alignment. It should be performed when:

1. An audio head is replaced (both the playback and record alignments must be done).
2. The Bias/Erase PWA is replaced or repaired (only the record alignment need be done).
3. An Audio PWA is replaced (both the playback and record alignments must be done).

3-102. Audio PWA 2 Adjustments. Refer to Figure 3-66 or 3-67 for component locations while performing this procedure. This procedure is performed with the aid of an audio alignment tape. The tape is recorded with a series of tones, each tone persisting from 10 seconds to 1 minute (tones selected by ANSI Institute). The tape is introduced by voice announcement, and each tone is announced as well. A speaker or headphones (speaker is standard with console models) must be used to identify tones. Track widths on the tape are much wider than those of normal VPR recorded audio tracks. The excessive track width causes excessive signal from the track fringe area (called fringing) to be picked up by the head(s). Increasing tone frequency decreases fringing such that, at 10 kHz, no fringing exists. The fringing value is unique to each tape and is included with the alignment tape.

NOTE

Component designators for PWA's incorporating piggyback PWA (assembly no. 1401022) are enclosed in parentheses in the procedure below, and are shown in Figure 3-67.

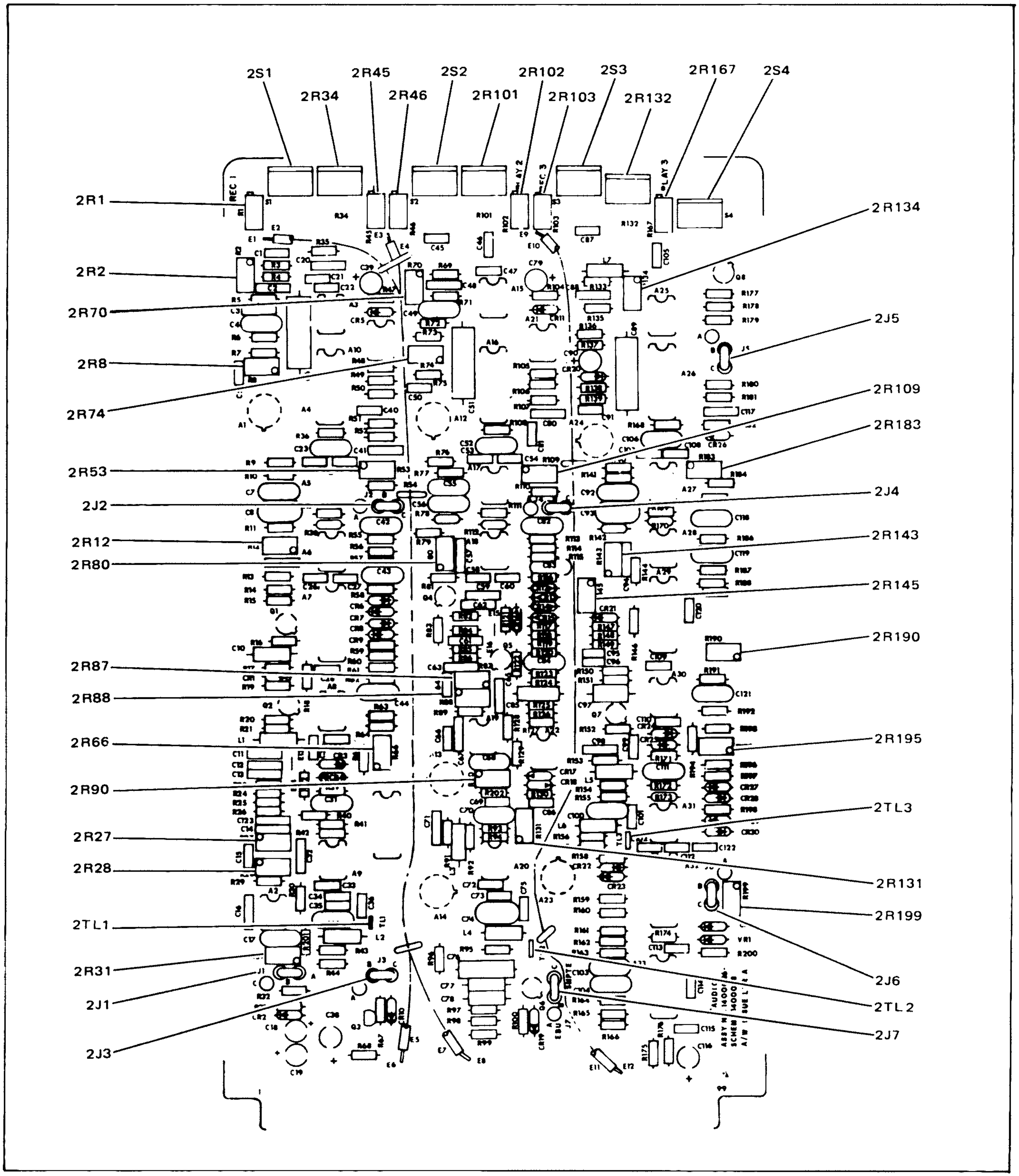


Figure 3-66. Audio PWA 2, Assembly No. 1400026

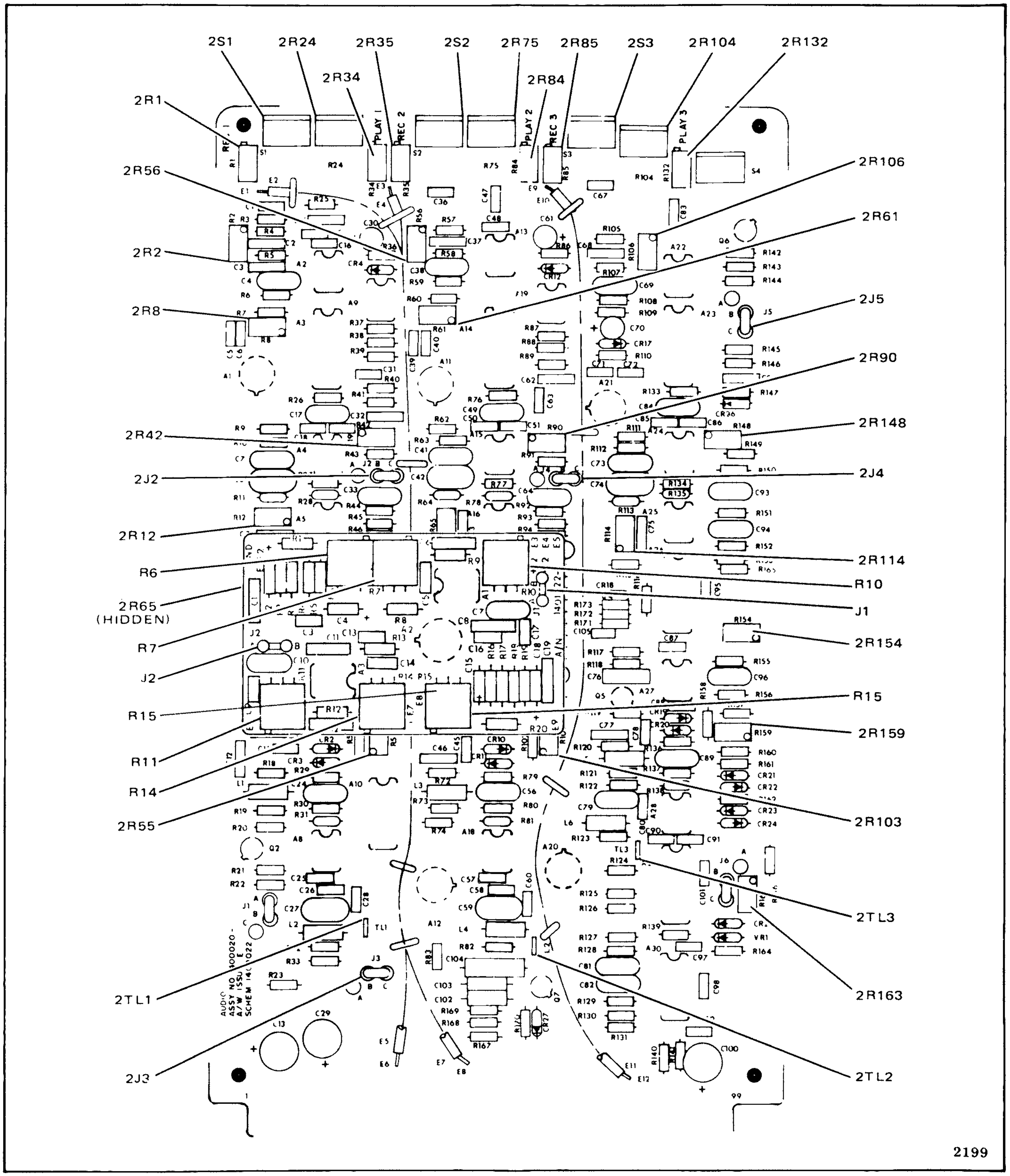


Figure 3-67. Audio PWA 2, Assembly No. 1400023

NOTE

Clean and demagnetize heads and tape path beofre each use of the audio alignment tape. Audio alignment tape frequency response should be checked periodically against that of a new audio alignment tape.

3-103. *Unity Playback Level and Frequency Response Adjustments.*

1. Thread the audio alignment tape onto the transport (see Table 3-1 for appropriate SMPTE or EBU Ampex Part Number).

2. With power off, remove Audio PWA 2 from electronics assembly. Place PWA on an extender board and reinstall into electronics assembly.

3. Connect audio voltmeter to the audio output connector corresponding to the channel being aligned. This procedure is written for channel 1. The user will follow-up by aligning channels 2 and 3 in the same manner.

4. Connect a 600-ohm 1-watt resistor across the audio voltmeter input terminals; an external speaker/amplifier may also be connected to the terminals to permit voice announcements to be monitored.

5. Set REC LOCKOUT on front edge of PWA 17 to ON (up) position (verify RECORD LOCKOUT LED lights). Set all audio record enable switches (AUDIO 1, AUDIO 2, AUDIO 3, [for EBU 4]) to OFF position (down).

6. Set all UNITY/PLAYBACK switches S1, S2, S3 (AUDIO 1, AUDIO 2, AUDIO 3/4 respectively) to UNITY position (down) (PWA front edge). Set TAPE/EE switch to TAPE.

7. Restore power and initiate PLAY mode; play back the 1-kHz level-set tone (first tone on alignment tape).

8. With 1-kHz tone playing follow one method below:

   a. Standard method. Adjust 2R45 (2R34), AUDIO 1 UNITY PLAYBACK LEVEL SET (Figure 3-67) for +8.0 dBm plus fringing data on the meter. Adjust 2R102 (2R84) (channel 2) and 2R167 (2R132) (channel 3) for +8.0 dBm plus fringing data on the meter. These screwdriver adjustable controls reside on the PWA front edge.

   b. Studio standard method. The unity playback levels may be set to a different value (within limits) then that specified above (example: 0 vu = 4 dBm). Set 2R45 (2R34) for the facility standard level on the meter, plus the fringing data value (i.e., +4.8 dBm). Set 2R102 (2R84) (channel 2) and 2R167 (1R132) (channel 3) for the facility level plus fringing data.

9. Play back the 10-kHz equalization level adjust tone. Adjust 2R2 (Audio 1 playback equalization adjust) for +8.0 dBm ±0.25 dB on the meter. Repeat this step for Audio 2 by adjusting 2R70 (2R56) and repeat for Audio 3 by adjusting 2R134 (2R106) (equalization potentiometers for the respective channels).

   Play back the remaining tones to verify that the frequency response does not deviate by more than 2 dB in either direction (±2 dB through the 50 Hz to 16 kHz range).

10. With power off, remove Audio PWA/extender from slot 2, separate the two, and reinstall Audio PWA into electronics assembly slot 2. Restore power.

11. Remove audio alignment tape from VPR.

3-104. Bias/Erase PWA 1 Adjustments. Refer to Figure 3-70 for component locations while performing this procedure. Perform Bias/Erase PWA adjustments:

1. Load bulk erased tape or new blank tape onto VPR.

2. With power off, remove Bias/Erase PWA 1 from the electronics assembly. Place the PWA on an extender board and reinstall into electronics assembly. Restore power.

3. Place VPR into record mode. Set VIDEO, AUDIO 1, AUDIO 2, AUDIO 3 and (as appropriate), SYNC or EBU AUDIO 4 record enable switches to ON. Proceed below:

3-105. *Erase Current Adjustments.*

1. Connect scope channel 1 to test lug 1TL1. Set scope to trigger from the line input (the audio waveform need not be synchronized in).

   a. Adjust AUDIO 1 ERASE CURRENT PEAKER 1L4 for greatest erase signal amplitude.

   b. Adjust AUDIO 1 ERASE CURRENT SET 1R33 for 0.25 Vp-p level.

2. Connect scope channel 1 to test lug 1TL2. Trigger from line input.

   a. Adjust AUDIO 2 ERASE CURRENT PEAKER 1L6 for greatest signal amplitude.

   b. Adjust AUDIO 2 ERASE CURRENT SET 1R47 for 0.25 Vp-p.

3. Connect scope channel 1 to test lug 1TL4 (trigger from line).

   a. Adjust AUDIO 3/EBU 4 ERASE CURRENT PEAKER 1L9 for greatest erase signal amplitude.

   b. Adjust AUDIO 3/EBU 4 ERASE CURRENT SET 1R83 for 0.25 Vp-p.

4. Connect scope channel 1 to test lug 1TL6 (trigger from line).

   a. Adjust VIDEO ERASE CURRENT PEAKER 1L14 for greatest erase signal amplitude.

   b. Adjust VIDEO ERASE CURRENT SET 1R133 for 5.0 Vp-p.

5. Connect scope channel 1 to test lug 1TL7 (trigger from line). Adjust CONTROL TRACK ERASE CURRENT SET 1R119 for 0.25 Vp-p (erase signal).

6. Connect scope channel 1 to test lug 1TL5 (trigger from line). Verify sync erase signal amplitude is 3.0 Vp-p ± 1.5V.

3-106. *Bias Drive Adjustments.*

1. While in record mode, connect scope channel 1 to test point 1TP1. Trigger from line input.

   a. Adjust AUDIO 1 BIAS PEAKER 1L1 for greatest bias amplitude.

   b. Adjust AUDIO 1 BIAS PEAKER 1T1 (transformer) for greatest bias drive amplitude.

2. Connect scope channel 1 to test point 1TP2 (trigger from line).

   a. Adjust AUDIO 2 BIAS PEAKER 1L7 for greatest bias amplitude.

   b. Adjust AUDIO 2 BIAS PEAKER 1T2 for (transformer) greatest bias drive amplitude.

3. Connect scope channel 1 to test point 1TP3 (trigger on line).

   a. Adjust AUDIO 3/EBU 4 BIAS PEAKER 1L10 for greatest bias amplitude.

   b. Adjust AUDIO 3/EBU 4 BIAS PEAKER 1T3 for greatest bias drive amplitude.

4. With power off, remove Bias/Erase PWA/ extender and replace PWA into slot 1. Restore power.

3-107. *Bias Optimization.* Perform this procedure for all audio channels. Connect test equipment to connectors for the channel being aligned; adjust the corresponding controls that are identified in the procedure. A bulk-erased tape must be used in the procedure. Any previously recorded material on the tape will invalidate alignment results.

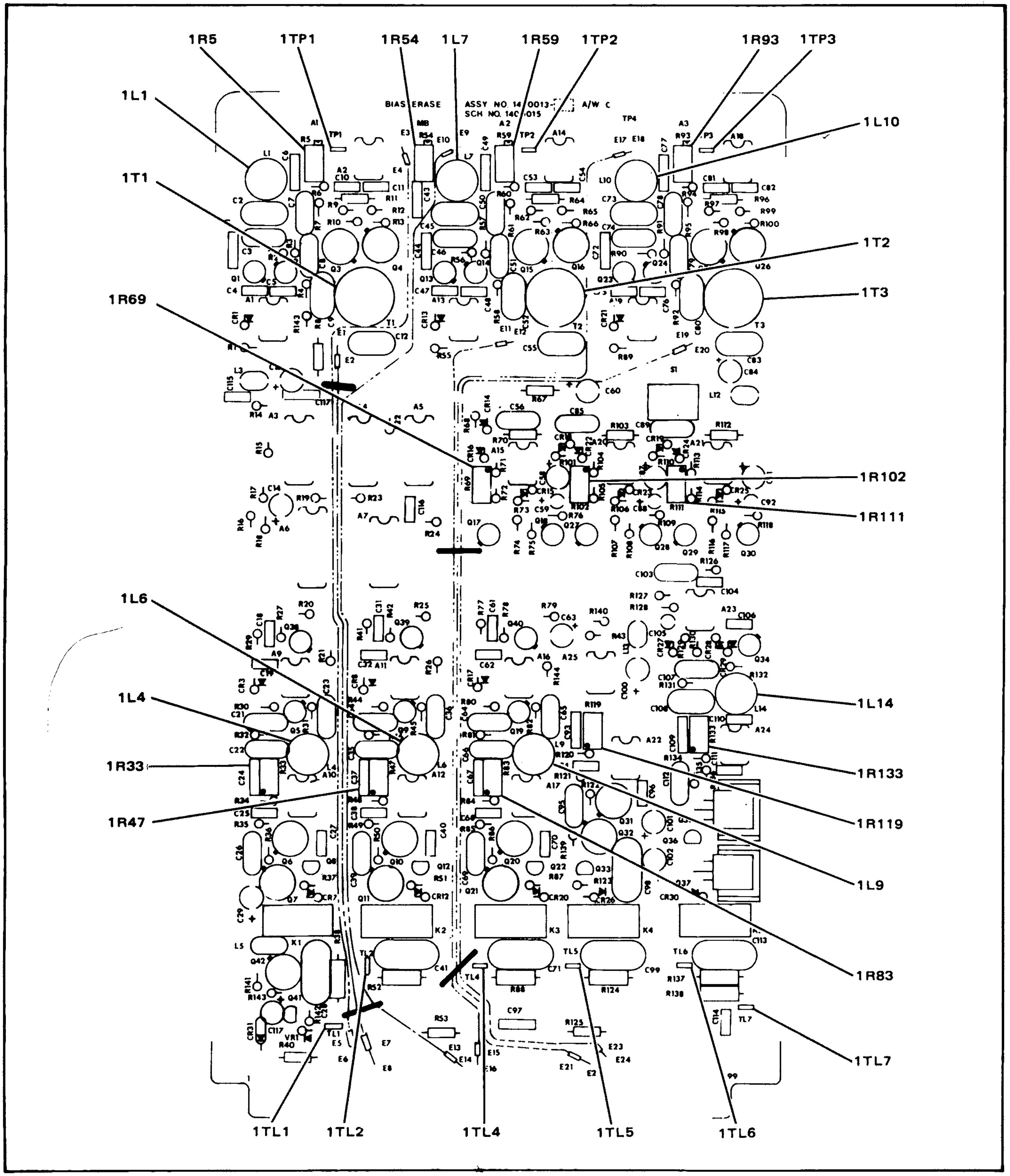


Figure 3-68. Bias/Erase PWA 1, Assembly No. 1400013

1. Thread a bulk-erased tape on the transport.

2. Set control panel switches: AUTO EDIT to OFF (down); VIDEO RECORD enable to ON. Verify REC LOCKOUT switch (PWA 17 front edge) is OFF.

3. Set 1R54 (MASTER BIAS adjust) on Bias/Erase PWA front edge to midrange position (see Figure 3-68 Bias/Erase PWA).

4. Set control panel audio record enable switches. To adjust channel 1, set AUDIO 1 to on, AUDIO 2 and AUDIO 3 to off. To adjust channel 2, set AUDIO 2 to on, 1 and AUDIO 3 (or EBU 4) to off. To adjust channel 3 (or EBU 4), set AUDIO 3 (or EBU 4) to on, AUDIO 1 and AUDIO 2 to off.

5. Connect the audio oscillator to the AUDIO 1 input connector (or to AUDIO 2, AUDIO 3, AUDIO 4 as appropriate). Set oscillator controls to provide 10 kHz at +8.0 dBm.

6. Connect audio voltmeter to the AUDIO 1 output connector (or AUDIO 2, AUDIO 3/ AUDIO 4 as appropriate). Terminate audio voltmeter input into 600 ohm.

7. At control panel, set RECORD LEVEL switch for AUDIO 1 (or AUDIO 2, AUDIO 3, as appropriate) to UNITY (push in).

8. Connect scope channel 1 to bias current test point, accessed at Bias/Erase PWA front edge: For AUDIO 1 use 1TP1; for AUDIO 2 use 1TP2; for AUDIO 3 use 1TP3. Trigger scope from line input.

9. Set BIAS LEVEL SET potentiometer (Bias/ Erase PWA front edge) fully counterclockwise: For AUDIO 1 set 1R5; for AUDIO 2 set 1R59; for AUDIO 3 set 1R93.

10. Initiate record mode.

11. Turn the BIAS LEVEL SET potentiometer clockwise in 10-mV increments (as observed on the scope) until potentiometer is fully clockwise. Log each increment; may be written, or by voice announcements on an unused channel. For channel 1 – turn 1R5; for channel 2 – 1R59; for channel 3 – 1R93.

12. Rewind tape to beginning of recording and initiate play mode.

13. Monitor audio voltmeter while listening to announced levels (or reading log). Set the BIAS LEVEL SET potentiometer (1R5 for AUDIO 1; 1R59 for AUDIO 2; 1R93 for AUDIO 3) to position corresponding to an over-bias condition of 1 dB. Note that as the bias level is increased, the 10-kHz playback signal will also increase, reach a peak and then begin to decrease. Set the BIAS LEVEL SET potentiometer to that position which corresponds to an over-peak of –1 dB.

NOTE

When changing tape type, only 1R54 (MASTER BIAS) need be readjusted.

3-108. *Record Level Calibration, Record Equalization, and E-E Calibration.* Perform this procedure for all audio channels. Connect test equipment to connectors for the channel being aligned; adjust the corresponding controls that are identified in the procedure. A bulk-erased tape must be used in the procedure. Any previously recorded material on the tape will invalidate alignment results.

The Bias/Erase and Audio PWA's must not be on extenders unless specifically called for in the procedure.

1. Load a bulk erased tape on the transport (if not already present).

2. Connect the audio oscillator to the AUDIO 1 input connector (or AUDIO 2, AUDIO 3 [or EBU 4] as appropriate). Set oscillator to 1 kHz at +8 dBm out. If the studio standard level is +4 dBm or lower than 0 dBm, set jumpers 2J2, 2J4, and 2J5 to A–C position.

3. Connect audio voltmeter to the AUDIO 1 output connector (or AUDIO 2, AUDIO 3 [or EBU 4] as appropriate). Terminate ac voltmeter input into 620 ohms.

4. Set control panel switches:

   a. Select AUDIO 1, AUDIO 2, AUDIO 3 (or EBU 4) record enable for the channel being aligned. Set all remaining record enable switches to OFF position.

   b. Set the corresponding RECORD LEVEL switch to UNITY (push in).

5. Place VTR in record mode for about 30 seconds.

6. Rewind the tape to the start of the recording. Initiate playback mode and verify that the ac voltmeter reads +8.0 dBm ± 0.25 dB.

   If the playback reading is incorrect, proceed as follows:

   a. Note the level. Remove VPR power, remove Audio PWA, place it on an extender, and restore PWA/extender to slot 2. Restore power.

   b. Set TAPE/EE switch to EE. Adjust 2R1 2R46 (2R35), or 2R103 (2R85) (AUDIO 1, 2, and 3/4 UNITY RECORD CALIBRATION potentiometers, respectively) for the difference in voltmeter reading. For example, if the playback reading is 2 dB low, increase the E-E reading by 2.0 dB.

   c. Remove VPR power, withdraw the PWA/extender, separate the two and restore the Audio PWA to slot 2. Restore power.

   d. Initiate record (for about 60 seconds). Play back the recording. The level observed on the ac voltmeter should now be +8.0 dBm or facility standard audio level.

7. To calibrate the E-E levels, proceed as follows:

   a. Remove VPR power. Extract Audio PWA, mate it to the extender, and restore extender/PWA to slot 2.

   b. Restore power; place machine in E-E mode (TAPE/EE switch to EE); press READY button to enter standby mode.

   c. Adjust 2R53 (2R42), 2R109 (2R90), or 2R183 (2R148) (Audio 1, 2, and 3/4 CALibration potentiometers respectively) for a +8.0 dBm or facility standard audio level output reading on the ac voltmeter. Verify that the front panel vu meters read 0 vu. If they do, proceed to step 9; if not, perform step 8.

   d. Remove VPR power. Extract PWA/extender, separate the two and restore Audio PWA to slot 2.

8 Vu meter calibration. If step 7 above did not produce zero vu readings on the front panel vu meters, proceed as follows:

   a. Remove VPR power; extract the bias/Erase PWA from slot 1; mate it to the extender and insert the PWA/extender into slot 1. Restore power.

   b. Place machine in E-E standby mode (TAPE/EE to EE, press READY). Adjust the vu CALibration potentiometers 1R69 (AUDIO 1), 1R102 (Audio 2), and 1R111 (Audio 3/4) for 0 vu reading in each case.

9. Record equalization. Proceed as follows:

   a. Set audio oscillator controls to provide 1 kHz at 0.0 dBm input level.

   b. Initiate record mode, record for about 60 seconds.

   c. Change oscillator frequency to 10 kHz at the same input level, and continue to record for about another minute.

   d. Rewind tape to beginning of recording. Enter playback mode and note the level of the 1 kHz playback signal; upon entering the 10 kHz portion of tape, the level should be the same as that noted for the 1 kHz portion ± 0.25 dB. If this requirement is met, step 10 (equalization adjustment) need not be done — proceed to step 11. If not, do step 10.

10. Record equalization adjustment. If step 9d above is not satisfied, adjust the record equalization level as follows:

a. Remove VPR power and withdraw the Audio PWA.

b. Adjust the RECORD EQUALIZATION potentiometer (on the Audio PWA) in the direction dictated by the results of step 9d. Adjust 2R12 (2R12), 2R80 (2R65) and 2R143 (2R114) for Audio 1, 2, and 3/4 respectively.

c. Reinsert Audio PWA into slot 2 and turn on power.

d. Perform steps 9b through 9d (above) to determine if the adjustment made was correct. Repeat step 10 as required to establish correct equalization for all channels. Note that this is a trial and error process. In every case the Audio PWA must be returned to the card cage since the extender board (if used) makes any results obtained invalid.

3-109. *Predistortion Adjustment.* Perform this procedure for all audio channels in the same manner as was done for previous procedures. A bulk-erased tape is used. Bias/Erase and Audio PWA's may not be on extenders unless so specified. This procedure requires the use of a spectrum or wave analyzer.

1. Load bulk-erased tape onto transport (if not already present).

2. Connect audio oscillator to the audio input connector for the channel under alignment. Set oscillator controls to provide 1 kHz at +14 dBm (+6 dBm higher than facility standard).

3. Connect the audio voltmeter and the spectrum analyzer to the audio output connector for the channel under alignment (use a T-connector).

   Set spectrum analyzer controls as follows:

a. Amplitude Mode	10 dB/div
b. Amplitude Ref Level	Normal
c. dBm	600 ohms
d. Resolution Bandwidth	100 kHz
e. Freq. Span/Div.	0.5 kHz
f. Sweep Time/Div.	1 sec
g. Display Smoothing	Minimum
h. Sweep Mode	Rep
i. Freq	00.0 kHz

   Adjust sensitivity so that 1-kHz signal falls on the top line of the graticule.

4. Set AUDIO 1, AUDIO 2, AUDIO 3 (or EBU 4) RECORD LEVEL control as appropriate (VTR front panel) to UNITY position (push in).

5. Remove power and extract Audio PWA from slot 2. Set predistortion level adjust potentiometer for the channel under alignment to the fully counterclockwise position. For Audio 1 adjust 2R66 (2R55); Audio 2, 2R131 (2R103; Audio 3 (or EBU 4), 2R195 (2R159). Verify that jumper 2J3 is in the B–C position.

6. Replace Audio PWA into slot 2 and restore power.

7. Initiate a 2-minute recording.

8. Terminate record mode and cue to the beginning of recording just made. Remove power, extract Audio PWA – place it on the extender, and place PWA/extender into slot 2. Restore power.

9. Connect scope channel 1 probe to audio record drive test point (test lug) for channel under alignment: Audio 1 – use 2TL1; Audio 2 – use 2TL2; Audio 3 (EBU 4) – use 2TL3. Trigger scope from line input.

10. Initiate a 10-second recording. While recording, note p-p signal amplitude displayed on scope.

If the scope is so equipped, connect vertical output for channel 1 to an ac voltmeter to measure amplitude level for audio channel under test.

11. Terminate recording. Move predistortion setup jumper 2J3 to A-B (SETUP) position. Place PLAYBACK UNITY/VARIABLE switch (Audio PWA front edge) to VARIABLE position: Audio 1 – 2S1; Audio 2 – 2S2; Audio 3 (EBU 4) – 2S3.

12. Enter playback mode. Adjust playback variable control to achieve a level that is 0.5 dB lower than that noted in step 10; Audio 1, adjust 2R34 (2R24); Audio 2, 2R101 (2R84); Audio 3 (EBU 4), 2R132 (2R132). Log the level obtained.

13. Noting the third harmonic on the spectrum analyzer, turn the predistortion level potentiometer slowly clockwise to minimize third harmonic distortion – as observed on spectrum analyzer. Third harmonic distortion should be –42 dB or greater below the fundamental. Cease adjustment upon reaching the first null. For Audio 1, adjust 2R66 (2R55); Audio 2, 2R131 (2R103) and Audio 3 (EBU 4), 2R195 (2R159).

14. Verify that level on ac voltmeter is within ±0.25 dB of level established in step 12. If it is not, readjust playback variable level potentiometer to obtain level logged in step 12. If adjustment was required, repeat step 13.

15. Repeat steps 5 through 14 for Audio 2 and Audio 3 (EBU 4). When finished, restore jumper 2J3 to B-C (NORMAL) position, and set UNITY/VARIABLE switches (front edge) to UNITY position.

16. Remove power and withdraw PWA/extender, separate the two, and restore Audio PWA to slot 2. Restore power.

17. Repeat step 13 to recheck third harmonic distortion levels for all audio channels (without adjusting potentiometers). The third harmonic should be –42 dB or greater below the fundamental.

3-110. *Playback Crosstalk Cancellation Adjustment.* Perform this procedure for channel 1 and channel 2 only. A bulk-erased tape is used. Audio PWA's may not reside on extenders unless so specified. This procedure employs a spectrum analyzer.

1. Load bulk-erased tape onto transport (if not already present).

2. Connect the audio oscillator to the audio input connector for the channel under alignment. Set oscillator controls to provide a 1 kHz at +8.0 dBm (or studio standard level).

3. Connect spectrum analyzer to the audio output connector for the channel under alignment.

4. Set the RECORD LEVEL switch for the channel under alignment (VTR front panel) to UNITY position (push in).

5. Set the UNITY P/B switch for both channel 1 and channel 2 (Audio PWA front edge) to the unity playback (UNITY P/B) position.

6. Set all audio RECORD SELECT switches on the VTR front panel to the off position (down). Set the RECORD SELECT switch for the channel under alignment (channel 1 or channel 2) to the on position (up).

7. Initiate a recording of about 2 minutes duration. Return tape to beginning of recording.

8. Initiate play mode. While recording is playing, perform the following (if recording expires, return to beginning as required):

   a. Set spectrum analyzer controls to display signal at a convenient reference point on the CRT. Log the signal amplitude.

   b. Move the spectrum analyzer cable to the AUDIO 1 or AUDIO 2 output connector opposite to that upon which the recording was made (if recording was made on channel 1, move cable to AUDIO 2 output connector). This action allows crosstalk to be observed.

c. Remove power, withdraw Audio PWA from slot 2 and place it on the extender. Plug PWA/extender into slot 2. Restore power.

d. Adjust CROSSTALK CANCELLATION ADJUST potentiometer for a minimum 1 kHz signal (crosstalk signal) on spectrum analyzer. If recording was made on channel 1 and channel 2 is being monitored, adjust 2R8. If recording was made on channel 2 and channel 1 is being monitored, adjust 2R61. The resulting crosstalk level must be –55 dB or greater below that level logged in step 8a.

3-111. *Record Playback Crosstalk Cancellation Adjustment.* Perform this procedure for channel 1 and channel 2 only. A bulk-erased tape is used. Audio PWA's may not reside on extenders unless so specified. This procedure requires an audio spectrum analyzer.

1. Load a bulk-erased tape onto the transport (if not already present).

2. Connect the spectrum analyzer sweep output to the channel 1 input connector. Set oscillator controls to provide a +8.0 dBm signal (or studio standard level).

3. Set the record level switch for channel 1 (VTR front panel) to UNITY position (push in).

4. Set the UNITY P/B switch for both channel 1 and 2 (Audio PWA front edge) to the unity playback position (UNITY P/B).

5. Connect spectrum analyzer input to the channel 1 output connector. Calibrate spectrum analyzer for full scale deflection.

6. Set all audio RECORD SELECT switches (VTR front panel) to the off position (down). Set the channel 1 RECORD SELECT switch to on (up).

7. Move spectrum analyzer input to AUDIO 2 output connector.

8. Initiate record mode. Adjust potentiometers 2R90, 2R88, and 2R87 (R14, R15, and R11) respectively for minimum signal as displayed on analyzer (potentiometers of some PWAs are located on the crosstalk cancellation piggyback board). Note that there is interaction between these controls. Therefore after initial adjustments, readjust all potentiometers for best overall minimum signal.

9. Move spectrum analyzer sweep output to the channel 2 input, and the analyzer's input to the channel 1 output.

10. Repeat steps 3 through 8 above but using channel 2 controls, and adjusting potentiometers 2R31, 2R38, and 2R27 (R7, R6, and R10) (piggyback board) respectively.

3-112. *Control-Track Crosstalk Cancellation.* Perform this procedure for a SMPTE version machine. To minimize control-track crosstalk into Audio 3, proceed as follows:

1. Remove VPR power. Withdraw the Audio PWA from slot 2, place it on the extender, and install PWA/extender in slot 2.

2. Connect scope channel 1 to pin 65 (CTL TRACK MONITOR) and scope channel 2 to pin 83 (AUDIO 3 PRE AMP INPUT).

3. With AUDIO 3 RECORD ENABLE switch off (control panel), place machine in record mode.

4. On scope channel 1, observe the 30 Hz square wave 500 mVp-p control track signal as shown in Figure 3-71 (set scope controls as required). On channel 2, observe positive and negative pulses (100 mV peaks) which are of opposite polarity with respect to the leading and trailing edges of the signal displayed on channel 1. If the signals are out of phase, proceed to step 5. If the signal (channel 2) is *not* of opposite polarity, the audio preamp connectors must be inverted. Proceed as follows:

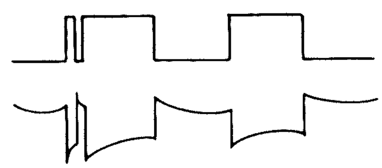


Figure 3-69. Control Track Cancellation Waveforms

a. Remove VPR power. Remove the tape from the machine. Remove the left-hand trim panel from the transport top.

b. Remove the two Phillips-head screws securing the mu-metal cover to the audio preamp assembly (cover is immediately left of the left-hand head stack assembly).

c. Disconnect P1, turn it over and reconnect it.

d. Replace mu-metal cover and trim panel.

e. Replace tape on machine and restore power.

f. Repeat steps 3 and 4 to verify that the phase is correct.

g. If phase is not correct, repeat step c above using P2. If still not correct, repeat using P3.

5. Set AUDIO 3 RECORD ENABLE switch to on. Pull AUDIO 3 RECORD LEVEL knob (front panel) out to VARIABLE position, and turn knob fully counterclockwise. Turn Audio 3 crosstalk cancellation potentiometer 2R145 (2R176) fully counterclockwise. Initiate record mode.

6. Find the optimum setting for 2R145 (2R176) (a 20-turn potentiometer) as follows:

a. Press RESET button to clear display and press ENTRANCE button to establish cue point (front panel).

b. While recording, slowly adjust control track cancellation potentiometer 2R145 (2R176) clockwise one turn at a time. Note the timer display reading relative to each turn of the potentiometer (keep track of number of turns).

c. When 2R145 (2R176) is fully clockwise, press SEARCH button to cue tape to beginning of recording.

d. Initiate playback and monitor AUDIO 3 OUTPUT on scope. Note the timer reading (and potentiometer position) at which the crosstalk is minimum (least crosstalk into Audio 3). This is the point of optimum crosstalk cancellation. The pulse level observed should be 40 mVp-p or less.

e. Adjust 2R145 (2R176) to optimum setting found in step 6d.

f. Step 6 may be repeated using smaller increments of the potentiometer (half-turn increments or smaller) to further improve cancellation.

7. Remove power and withdraw the PWA/extender from slot 2. Separate the PWA from

the extender and return the Audio PWA to slot 2.

3-113. EBU Audio PWA. This is a complete checkout and alignment procedure for the optional EBU Audio PWA and dependent circuitry which provides the fourth audio channel. Also included is the control track crosstalk cancellation procedure for EBU Audio 3.

These test procedures may be used to check overall EBU Audio 3 circuitry performance. If tests are satisfactory, then the alignment procedures which follow need not be performed.

NOTE

These procedures have been performed at the factory and need be repeated only when a repaired or replaced EBU Audio PWA or head assembly has been installed into the recorder. The record alignment procedure (only) must be performed when the type of tape used is changed.

Like procedures for other audio channels, the following factors apply:

- After completing EBU Audio procedures, repeat the EBU Audio system checks to verify correct performance.
- Input/output levels are adjusted to +8 dBm (0 vu) or facility standard audio level by use of a tape having a 1-kHz signal at a flux level of 100 nWb/m.
- The extender board is not used while making adjustments unless specified.
- The head and tape path are cleaned and demagnetized before commending with procedures. The head and tape path are cleaned and demagnetized before commencing with procedures.
- The capstan servo, scanner servo, and control track systems must operate properly.
- Power is always removed before removing or replacing a PWA.
- Tape tension/torque values are correct, and tape edge damage does not occur.
- Readings are taken with a 600-ohm resistor across the ac voltmeter input terminals.

NOTE

Certain jumpers listed in Table 3-3 affect VPR configurations as an EBU system—both with and without EBU Audio 4. Refer to jumper listings in Table 3-3 for the Audio I/O board, the Audio PWA (slot 2), and to the Control PWA (slot 17) to ensure that the machine in question is configured properly. In addition, the front panel SYNC/AUDIO 4 switch must be set properly.

3-114. EBU Audio System Checks. Use these procedures to check overall EBU Audio performance.

3-115. *Playback Level and Frequency Response.* Assess overall system operation using the EBU audio alignment tape (see Table 3-1 for Ampex Part Number). The tape presents a series of tones; each tone is introduced by voice announcement. The fringing data for the tape is listed on, or included with, the tape used.

CAUTION

DO NOT PROCEED IF THE TAPE PATH HAS NOT BEEN CLEANED AND DEGAUSSED. TO DO SO MAY DEGRADE THE PRECISION ALIGNMENT TAPE.

1. Load the EBU audio frequency response and playback level alignment tape onto VPR. Note the fringing data correction factors specified for this tape.
2. Set controls and make connections:

   a. Set UNITY/VARIABLE switch S1 (EBU Audio PWA front edge) to UNITY position.

b. Set all RECORD ENABLE switches (control panel) to OFF (down) position.

c. Connect an audio voltmeter to the AUDIO 3 output connector (I/O panel, rear of machine).

d. Connect a 600-ohm, 1-watt resistor across voltmeter input terminals; a speaker/amplifier may also be connected across terminals (to hear announcements) if desired (consoles have speakers in them).

e. Set REC LOCKOUT (Control PWA front edge) to ON postion. Verify that RECORD LOCKOUT LED lights.

3. Initiate play mode and verify the following:

a. While playing back the 1-kHz tone, the voltmeter reads (for standard operation) +8.0 dBm, plus fringing data value from tape. If facility level used is +4.0 dBm, verify reading is +4.0 dBm plus fringing value.

b. With 10-kHz tone playing, verify that the voltmeter reads +8.0 dBm ±0.25 dB (or +4.0 dBm ±0.25 dB if this facility level applies).

c. Play portions of tape producing tones ranging from 63 Hz to 16 kHz. Verify that the frequency response through the entire range is within ±2.0 dB of step 3c value.

3-116. *Overall Audio Frequency Response.* Check AUDIO 3 frequency response.

1. Connect an audio oscillator to the AUDIO 3 INPUT connector.

2. Set oscillator frequency to 1.0 kHz and adjust oscillator output level to 0 dBm at VPR input.

3. Connect ac voltmeter to AUDIO 3 OUTPUT connector.

4. Connect 600-Ohm 1-watt resistor across ac voltmeter terminals.

5. Thread a reel of bulk erased tape onto the transport.

6. Set AUDIO 3 RECORD LEVEL switch/control to UNITY position (in).

7. Check unity gain: Apply power and set TAPE/EE switch to EE (enter E-E mode) and verify that ac voltmeter indicates 0 dBm.

8. Set Control PWA RECORD LOCKOUT switch to OFF. Set AUDIO 3 RECORD ENABLE switch (control panel) to ON.

9. Make a short recording of the following frequencies while maintaining a 0 dBm input level for all frequencies: 50 Hz, 100 Hz, 500 Hz, 1.0 kHz, 5.0 kHz, 10.0 kHz, 12.0 kHz, and 15.0 kHz.

10. Rewind the tape, enter play mode, and check the playback level and response. The 1 kHz level should be 0.0 dBm ±0.5 dBm. The response should be within the limits of +2 to –3 dB from 50 Hz to 15.0 kHz as referenced to the 1.0 kHz level.

11. After verification of the playback level (0 dBm), check the operation of the PWA front edge green LED. Increase the audio oscillator output level to provide +8.0 dBm at 1 kHz. The green LED (board edge) should be lit.

3-117. *Audio Harmonic Distortion.* It is recommended that harmonic wave levels be measured using a spectrum or wave analyzer (the use of a total harmonic distortion analyzer to measure off-tape distortion is not recommended). The audio oscillator used for measurement should not have a residual second harmonic component greater than 0.03% rms (–70 dB) for fundamental frequencies from 500 Hz to 1.0 kHz. Also the third harmonic component should not be greater than 0.05% rms (–66 dB).

1. Connect an audio oscillator to the AUDIO 3 INPUT connector.

2. Set oscillator frequency to 1.0 kHz and adjust oscillator output level to +8 dBm.

3. Connect the input of the spectrum analyzer to the AUDIO 3 OUTPUT connector of the VPR.
4. Connect a 600-ohm resistor across the spectrum analyzer input terminals.
5. Set AUDIO 3 RECORD LEVEL switch/ control to UNITY "in" position.
6. Set the spectrum analyzer controls as follows:

a. Amplitude	10 dB/div
b. Amplitude Ref Level	Normal
c. dBm	600 ohms
d. Display	Reduced bandwidth
e. Resolution Bandwidth	100 Hz
f. Freq Span/Div	0.5 kHz
g. Switch Time/Div	1.0 sec
h. Sweep Mode	Rep

7. Apply power and set TAPE/EE switch to EE.
8. Adjust input sensitivity on spectrum analyzer so that the 1.0-kHz signal touches the top line of the scope graticule.
9. Make a 1-minute recording of the 1.0 kHz signal.
10. Rewind the tape and enter play mode.
11. Adjust spectrum analyzer to measure second harmonic content (2.0 kHz); this should be 50 dB or better.
12. Adjust spectrum analyzer to measure third harmonic content (3.0 kHz); this should be 42 dB or better.
13. Check third harmonic content at +14 dBm peak operating level as follows:
    a. Adjust oscillator output level for +14 dBm at 1.0 kHz (+6 dBm higher than facility standard level).
    b. Make a 1-minute recording on channel 3.
    c. Rewind the tape and enter play mode.
    d. Third harmonic (3.0 kHz) content on channel 3 should be 32 dB or better.

3-118. *Audio Erasure.* Audio erasure is measured by first making a recording at +14 dBm peak operating level, and then erasing the tape while making a "no signal" recording. This "no signal" recording is then checked for residual signal using a spectrum analyzer. Proceed as follows:

1. Connect an audio oscillator to the AUDIO 3 INPUT connector.
2. Set oscillator frequency to 1.0 kHz and adjust oscillator output level to +14 dBm.
3. Connect the input of the spectrum analyzer to the AUDIO 3 OUTPUT connector of the VPR.
4. Connect a 600-ohm resistor across the spectrum analyzer input terminals.
5. Set AUDIO 3 RECORD LEVEL switch/ control to UNITY "in" position.
6. Set the spectrum analyzer controls as follows:

a. Amplitude Mode	10 dBm/div
b. Amplitude Ref Level	Normal
c. Switch	dBm 600 ohms
d. Display	Reduced bandwidth
e. Resolution Bandwidth	100 Hz
f. Freq Span/Div	0.5 kHz
g. Sweep Time/Div	1.0 sec
h. Sweep Mode	Rep

7. Apply power and set TAPE/EE switch to EE.

8. Adjust input sensitivity on spectrum analyzer so that the 1.0-kHz signal touches the top line of the scope graticule.

9. Make a 1-minute recording of the 1.0-kHz signal.

10. Rewind the tape to the beginning of the recording.

11. Remove the oscillator and short all three pins of the AUDIO 3 INPUT connector together.

12. Enter record mode to erase the recording made in step 9.

13. Rewind the tape to the beginning of the recording made step 9 and enter play mode.

14. Measure the residual signal content on the erased portion of the tape on the spectrum analyzer. Erased portion should be –70 dB or better.

3-119. *Audio Signal-to-Noise Ratio and Internal Time Code.* Audio signal-to-noise ratio is measured referenced to a +14 dBm (+6 dBm higher than facility standard audio level) peak operating level. Proceed as follows:

1. Thread a reel of bulk erased tape onto the transport.

2. Short all three pins of the AUDIO 3 INPUT connector together.

3. Connect an ac voltmeter to the AUDIO 3 OUTPUT connector.

4. Connect a 600-ohm 1-watt resistor across the ac voltmeter terminals.

5. Set AUDIO 3 RECORD LEVEL switch/control to UNITY "in" position.

6. Enter record mode for 1 minute.

7. Rewind tape to beginning of recording and enter play mode. The playback signal should be –50 dBm (or –36 dBm as read on ac voltmeter).

8. Check internal time code (if machine equipped with Time Code Reader/Generator option.) Proceed as follows:

   a. Set TAPE/EE switch to EE.

   b. Set LINE/MIC/TC switch 3S3 (PWA front edge) to TC (time code) position (see Figure 3-70).

   c. Remove power and withdraw PWA 3. Move EXT TC jumper 3J1 to B–C position. Replace EBU Audio PWA into slot 3 and restore power.

   d. Verify front panel vu meter (AUDIO 3) reads +2.

   e. Remove power and withdraw PWA 3 to restore jumper J1 to A–B position and switch 3S3 to LINE position (if external time code not used). Replace PWA and restore power.

3-120. *Control Track Crosstalk Cancellation.* This procedure applies to EBU version machines, both with and without the optional EBU Audio 3 PWA which (when present) occupies slot 3 of the electronics assembly. When operating as a 4-channel system, the Audio 3 electronics on PWA 2 (Audio PWA) becomes Audio 4.

On both 3 and 4 channel systems, Audio 3 occupies the bottom edge track on tape. On the 4-channel system, Audio 4 occupies the track adjacent to the control track. Due to the nature of the low-level biased EBU control track (record level of 100 nWb), Audio 4 (and, to a lesser extent, Audio 3) crosstalks into control track playback during insert edits.

Use the procedure below to check control track cancellation and thereby ensure proper system performance. If alignment is indicated, proceed to the *Control-Track Crosstalk Cancellation* procedure, paragraph 3-129.

1. Thread the EBU bias control track reference level tape onto the transport (see Table 3-1 for Ampex Part Number).

2. Connect scope probe to Control Track PWA 14TP2 (MONITOR FRAME, PWA front edge).

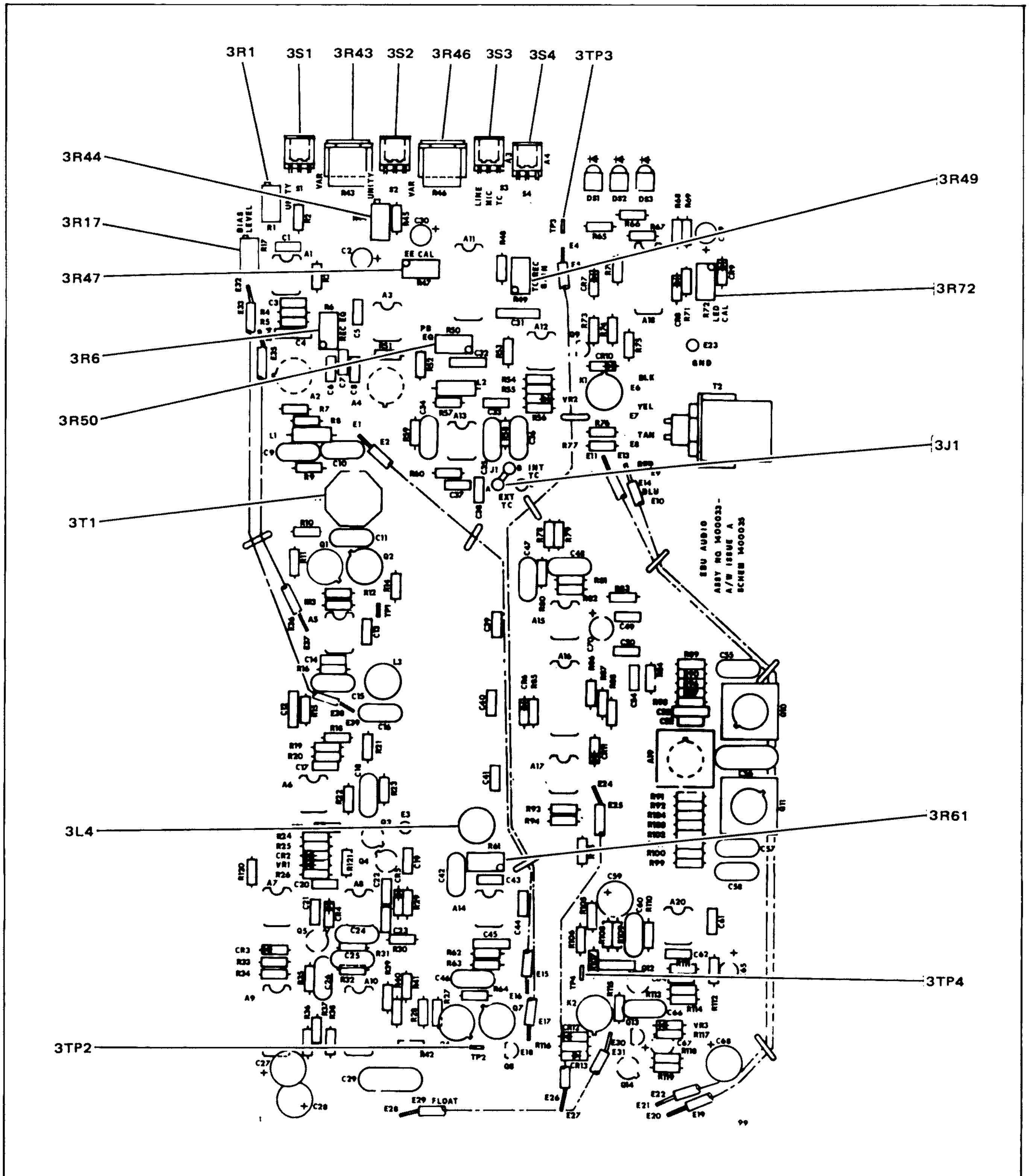


Figure 3-70. EBU Audio PWA 3, Assembly No. 1400033

3. Set RECORD LOCKOUT switch 17S1 to on, and front panel EDIT switch to INSERT.

4. Initiate playback and verify that the control-track level observed on the scope measures 6.5 ± 0.5 Vp-p.

NOTE

The control-track test tape provides a 1-kHz tone recorded at 100 nWb.

5. Rewind and remove the alignment tape. Thread a bulk-erased tape onto the transport.

6. Place VPR in standby mode (scanner not running). Set TAPE/EE switch to EE.

7. Connect an audio oscillator to the AUDIO 3 INPUT connector (rear panel). Set oscillator controls to provide 1 kHz at +8 dBm. Connect an ac voltmeter to the AUDIO 3 OUTPUT connector.

8. Pull out the Audio 3/4 RECORD LEVEL knob (VARIABLE position). Adjust knob for an output level that is +20 dB above the operating level.

9. Set UNITY/VARIABLE switch (PWA 3 front edge) to VARIABLE position and adjust for a level 20 dB over operating level.

10. Set RECORD LOCKOUT switch 17S1 (Control Track PWA front edge) to OFF and all RECORD ENABLE switches (front panel) to ON (up).

11. Initiate record mode and note playback level on scope. The Audio 3 crosstalk into control track should be 2.5 Vp-p or less through the range of from 100 Hz through 15 kHz. (Note: Record control track need not be present.)

12. Remove test gear and restore VPR to normal operating condition or proceed to EBU *Audio Alignment* procedures (immediately following) as appropriate.

3-121. EBU Audio Alignment. Use this procedure to align the EBU Audio PWA and dependent circuits after a repair or component replacement. (See Figure 3-70.)

3-122. *Unity Playback Level and Frequency Response Adjustments.*

CAUTION

DO NOT PROCEED IF THE TAPE PATH HAS NOT BEEN CLEANED AND DEGAUSSED. TO DO SO MAY DEGRADE THE PRECISION ALIGNMENT TAPE.

1. Load the EBU audio frequency response and playback level adjustment tape onto the VPR (see Table 3-1 for Ampex part number). Note the fringing data correction factors specified for this tape.

2. Set controls and make connections:

   a. Set UNITY/VARIABLE switch 3S1 (EBU Audio PWA front edge) to UNITY position.

   b. Set all RECORD ENABLE switches (control panel) to OFF (down) position.

   c. Connect an audio voltmeter to the AUDIO 3 output connector (I/O panel, rear of machine).

   d. Connect a 600-ohm, 1-watt resistor across voltmeter input terminals; a speaker/amplifier may also be connected across terminals (to hear announcements) if desired (consoles have speakers in them).

   e. Set REC LOCKOUT (Control PWA front edge) to ON position. Verify that RECORD LOCKOUT LED lights.

3. Initiate play mode and perform the following:

   a. While playing back the 1-kHz tone, adjust potentiometer 3R1 (UNITY PLAYBACK LEVEL) so voltmeter reads (for standard operation) +8.0 dBm, plus fringing data

value from tape. If studio level used is +4.0 dBm, verify reading is 4.0 dBm plus fringing value.

b. With 10-kHz tone playing, adjust potentiometer 3R50 (PLAYBACK EQUALIZER) so voltmeter reads +8.0 dBm ±0.25 dB (or +4.0 dBm ±0.25 dB if this studio level applies).

c. Play portions of tape, producing tones ranging from 63 Hz to 16 kHz. Verify that the frequency response through the entire range is within ±2.0 dB of step 3b value.

3-123. *Bias/Erase Level Optimization.* Proceed as follows:

1. Remove VPR power, extract EBU Audio PWA (slot 3), place it on an extender, and insert PWA/extender into slot 3.

2. Thread a bulk-erased tape onto the transport.

3. Set Audio 3 RECORD ENABLE switch (front panel) to ON, and RECORD LOCKOUT switch 17S1 (Control PWA front edge) to OFF.

4. Connect scope probe to 3TP2 and adjust variable inductor 3L4 for maximum signal on scope.

5. Move scope probe to 3TP3 and adjust variable transformer 3TP1 for maximum signal on scope.

6. If the next alignment procedure (below) is to be performed, proceed directly there. If not, remove VPR power, separate the EBU Audio PWA and extender, remove scope probe, and restore the PWA to slot 3.

3-124. *Bias Optimization.* A bulk-erased tape must be used for the procedure below. Any previously recorded material on the tape will invalidate alignment results. The test point and potentiometer called out during the procedure reside on the interior of the board. However, the EBU Audio PWA may not be on the extender while calibrating the circuit. Therefore, for each adjustment made, the machine is powered down and PWA 3 extracted from the electronics assembly. The board is then replaced to slot 3 and power reapplied.

1. Thread a bulk-erased tape onto the transport.

2. Set control panel switches: AUTO EDIT to OFF (down); AUDIO 3 RECORD ENABLE to ON; all other audio record enable switches to off. Verify REC LOCKOUT switch (PWA 17 front edge) is off.

3. Connect audio oscillator to AUDIO 3 INPUT connector. Set oscillator controls to produce 10 kHz at +8.0 dBm. Connect ac voltmeter to AUDIO 3 OUTPUT connector.

4. Set PWA 3 RECORD LEVEL switch (front edge) to UNITY position.

5. Remove the EBU Audio PWA to perform the following (remove power and observe all precautions):

   a. Connect scope probe 1 to bias current test point 3TP1 (a small clip lead or similar device must be used to allow PWA replacement into slot 3).

   b. Set BIAS LEVEL SET potentiometer 3R17 to full counterclockwise position.

   c. Replace PWA into slot 3 and restore power.

6. Initiate record mode.

7. While recording, turn BIAS LEVEL SET potentiometer 3R17 clockwise in 10 mV increments – as observed on the voltmeter. Do this until the potentiometer is fully clockwise. Log each increment, may be written, or by voice announcements on an unused channel. Note that 3R17 is not accessible while PWA is in the electronics chassis. Remove power to extract the PWA and make incremental adjustments.

8. Rewind tape to beginning of recording. Enter play mode.

9. Monitor voltmeter while listening to announced levels (or reading log). Determine what potentiometer position produced an over-biased condition of 1 dB. Note that as the bias level is increased, the 10 kHz playback signal will also increase – reach a peak, then begin to increase.

10. Set 3R17 to that position which corresponds to an overpeak (overbiased condition) of 1dB. Remove power and extract PWA 3 as required.

3-125. *Record Level Calibration, Record Equalization, and E-E Calibration.* A bulk-erased tape must be used in the procedure. Any previously recorded material on the tape will invalidate alignment results. The Bias/Erase and Audio PWA's must not be on extenders unless specifically called for in the procedure.

1. Load a bulk-erased tape on the transport (if not already present).

2. Connect the audio oscillator to the AUDIO 3 input connector. Set oscillator to 1 kHz at +8 dBm out.

3. Connect audio voltmeter to the AUDIO 3 output connector. Terminate ac voltmeter input into 600 ohms.

4. Set control panel switches:

   a. Select AUDIO 3 record enable switch. Set all remaining record enable switches to OFF position.

   b. Set Audio 3 RECORD LEVEL switch to UNITY (push in).

5. Place VTR in record mode for about 30 seconds.

6. Rewind the tape to the start of the recording. Initiate playback mode and verify that the ac voltmeter reads +8.0 dBm ± 0.5 dB.

   If the playback reading is incorrect, proceed as follows:

   a. Note the difference between the playback level and the required level.

   b. Remove VPR power and place PWA 3 on the extender. Restore power and initiate E-E mode.

   c. Adjust 3R1 (UNITY RECORD GAIN potentiometer) to compensate for the difference in the two levels (e.g., if playback level was +10 dBm, adjust 3R1 to lower E-E output by 2 dB; if playback level was +4 dBm, adjust 3R1 to increase E-E output level reading by 4 dB). After adjusting 3R1 in this manner, adjust EE CALIBRATE potentiometer 3R47 for an output level of +8.0 dBm.

   d. Remove VPR power. Remove extender/PWA, separate the two, and restore PWA to slot 3. Restore power.

   e. Make a recording of about 30 seconds.

   f. Cue to the beginning of the recording and initiate playback. Verify that the ac voltmeter reads +8.0 dBm ± 0.25 dB. If it does not, repeat steps 6a through 6f as required.

7. LED level calibration. With VTR in E-E mode; (1 kHz at +8.0 dBm input and +8.0 dBm output), adjust 3R72 to light the front edge green LED. (Check overall circuit operation and by turning potentiometer stop to stop, lighting all LED's. Finish up by centering potentiometer in range which lights green LED.)

8. Record equalization. Proceed as follows:

   a. Make a recording under these conditions:

      (1) Bulk-erased tape is on transport.

      (2) AUDIO 3 RECORD ENABLE switch is on (all other audio channels are disabled).

      (3) Supply a 1 kHz +8.0 dBm input signal.

b. While recording, change input frequency to 10 kHz at +8.0 dBm.

c. Cue to the beginning of the recording and initiate playback.

d. Verify that the 10-kHz portion plays back at the same level as the 1-kHz portion, ±0.25 dB. If it does not, adjust RECORD EQUALIZATION potentiometer 3R6 (removing power and PWA, and observing all precautions). Repeat steps 8a through 8d to ensure adjustment was correct.

9. Overall response. Proceed as follows:

a. Initiate a recording exactly as was done for step 8a above.

b. While recording, sweep oscillator frequency through the range of from 50 Hz to 15 kHz, maintaining a +8.0 dBm level.

c. Cue to the beginning of the recording and initiate playback.

d. Verify that the playback level does not deviate by more than +2 dB to −3 dB through the frequency range, as referenced to the 1-kHz playback level.

3-126. *Signal-to-Noise.* Proceed as follows:

1. Load a bulk-erased tape onto VPR.

2. Short the three pins of the AUDIO 3 INPUT connector together. Connect ac voltmeter to AUDIO 3 OUTPUT connector.

3. Make a short recording.

4. Cue to the beginning of the recording and initiate playback.

5. Verify that the noise level is down by −50 dB (reads −36 dBm on meter as referenced to nominal +14 dBm), or better.

3-127. *Erase Alignment.* Proceed as follows:

1. Remove power, withdraw PWA 3, and connect scope probe to 3TP4 (use small clip lead or similar device). Replace PWA into slot 3 with probe attached. Restore power.

2. Connect audio oscillator to AUDIO 3 INPUT connector. Set oscillator controls to provide 1 kHz at +8.0 dBm.

3. Connect spectrum analyzer input to AUDIO 3 OUTPUT connector. Connect 600-ohm resistor across spectrum analyzer input terminals.

4. Set AUDIO 3 RECORD LEVEL switch to UNITY position, and TAPE/EE switch to EE.

5. Set spectrum analyzer controls:

a. Amplitude Mode	10 dB/div
b. Amplitude Ref Level	Normal
c. Switch	dBm 600 ohms
d. Display	Reduced bandwidth
e. Resolution Bandwidth	100 Hz
f. Freq. Span/Division	0.5 kHz
g. Switch Time/Division	1.0 sec
h. Sweep Mode	Rep

6. Enter record mode. Verify signal on scope measures 400 mVp-p. If it does not, proceed as follows:

a. Remove power and extract PWA 3 from slot 3.

b. Adjust ERASE LEVEL potentiometer 3R61 clockwise (increase) or counterclockwise (decrease) to affect the required level.

c. Replace EBU Audio PWA into slot 3, restore power, enter record, and verify 400 mVp-p signal displays on scope. Repeat steps 6a through 6c as required.

7. Adjust spectrum analyzer input sensitivity so that 1-kHz signal touches top line of scope graticule.

8. Make a 1-minute recording of the 1-kHz signal.

9. Rewind tape to beginning of recording just made.

10. Remove oscillator input and short all three pins of the AUDIO 3 IN connector together.

11. Enter record mode to erase recording made in step 8 above.

12. Rewind tape to beginning of recording made in step 11.

13. Enter play mode. Measure the residual signal content on the erased portion of tape using spectrum analyzer. The erased portion should be −70 dB down or greater. If this requirement is not met, readjust potentiometer 3R61 using steps 6a, 6b, and 6c.

3-128. *Internal Time-Code Setup.* Proceed as follows:

1. Remove power and extract EBU Audio PWA. Place it on the extender and insert PWA/ extender into slot 3.

2. Move jumper 3J1 to B–C (INTernal time code) position. Set switch 3S3 to TC (time code) position.

3. Set front panel TAPE/EE switch to EE position.

4. Adjust TC RECORD GAIN potentiometer 3R49 for a reading of +2 on the front panel vu meter.

5. Remove power, withdraw extender/PWA, separate the two, and replace EBU Audio PWA into slot 3.

3-129. *Control-Track Crosstalk Cancellation.* Proceed as follows:

1. Remove VPR power, place Control Track PWA on the extender, and replace PWA/ extender into slot 14. Restore power.

2. Setup:

   a. Connect scope channel 1 to test point 14TP2 (front edge, see Figures 3-46, 3-47). Trigger scope internally.

   b. Connect audio oscillator to AUDIO 4 INPUT connector, rear panel. Set oscillator controls to provide 100 Hz at 20 dB above the operating level.

   c. Set controls; EDIT switch to INSERT AUDIO 4 RECORD ENABLE to ON (all others OFF), set potentiometer 14R44 to midrange. (Note: On certain early version boards, this potentiometer is designated 14R88.)

3. Initiate record and enter an insert edit.

4. Adjust Audio 4 crosstalk level adjust potentiometer 14R49 (designated 14R87 on some early version boards) for minimum signal at 14TP2. Increase the scope vertical sensitivity as required; oscillator is at 100 Hz/20 dB above operating level. The level observed should be 2.5 Vp-p or less.

5. Set oscillator to 1 kHz at 20 dB above operating level.

6. Adjust phase adjust potentiometer 14R44 (designated 14R88 on some early version boards) for minimum signal at 14TP2. Repeat steps 4 through 6 as required until the signal observed at both 100 Hz and at 1 kHz is at a relative minimum (the null at both frequencies balances out).

7. Sweep oscillator frequency from 100 Hz through 15 kHz while maintaining a level of 20 dB above operating level.

8. Monitor 14TP2 (with scope) to verify that the residual crosstalk is no greater than 2.5 Vp-p through the range of 100 Hz to 15 kHz. If residual crosstalk is greater at other frequencies, readjust 14R87/14R88 for minimal crosstalk at these frequencies.

9. Connect audio oscillator to AUDIO 3 INPUT connector. Set oscillator controls for 100 Hz. Set oscillator and/or VPR controls to provide an output level (AUDIO 3 OUTPUT) of +20 dB above operating level.

10. Connect scope probe to 14TP2.

11. Initiate record and insert edit mode.

12. While recording, adjust Audio 3 crosstalk level potentiometer 14R53 (designated 14R94 on some early version board) for minimum crosstalk at 100 Hz; must be less than 2.5 Vp-p.

13. Sweep oscillator frequency through the range of 100 Hz to 15 kHz. Verify that the crosstalk level remains below 2.5 Vp-p throughout the range.

14. Connect oscillator output to AUDIO 3 and AUDIO 4 INPUT connectors in parallel. Set oscillator for 100 Hz, and oscillator/VPR controls for Audio 3, 4 output levels of +20 dB over standard operating level (both channels).

15. Initiate record, insert edit mode.

16. While recording, verify that crosstalk signal present at 14TP2 is less than 3 Vp-p. Sweep oscillator from 100 Hz to 15 kHz. Verify level remains below 3 Vp-p.

17. Remove power. Withdraw extender/PWA, separate the two, and restore Control Track PWA to slot 14.

3-130. Time Code Reader/Generator PWA 16 Checkout Procedure. Procedures for this unit may be found in the TC R/G operation and Maintenance manual, Ampex Catalog No. 1809499.

3-131. Monitor Select PWA. This PWA is located in the monitor bridge accessory. On its front edge, it incorporates monitor select switches which afford selection of signals displayed by the picture monitor, vectorscope, and waveform monitor accessories.

Refer to Figure 3-71 for component locations. Align this PWA as follows:

1. Turn VPR power off and perform the following:

   a. Remove four screws securing Monitor Select PWA cover plate.

   b. Remove two screws securing Monitor select PWA and extract PWA.

   c. Place PWA onto TBC extender and insert PWA/extender into slot.

   d. Restore VPR power.

2. Connect appropriate NTSC or PAL television signal generator to video and sync connectors of VPR console I/O panel. Select stairstep input video.

3. Set input video amplitude gain and dc balance.

   a. Connect scope channel A to PWA pin 57 (video in) and scope channel B to .TP9.

   b. Press monitor select switches VIDEO and VIDEO IN.

   c. Place VPR TAPE/EE switch in EE position and enter standby mode.

   d. Adjust input video amplitude gain R281 (Monitor Select PWA) for unity gain — video amplitude at TP9 equals video amplitude at input.

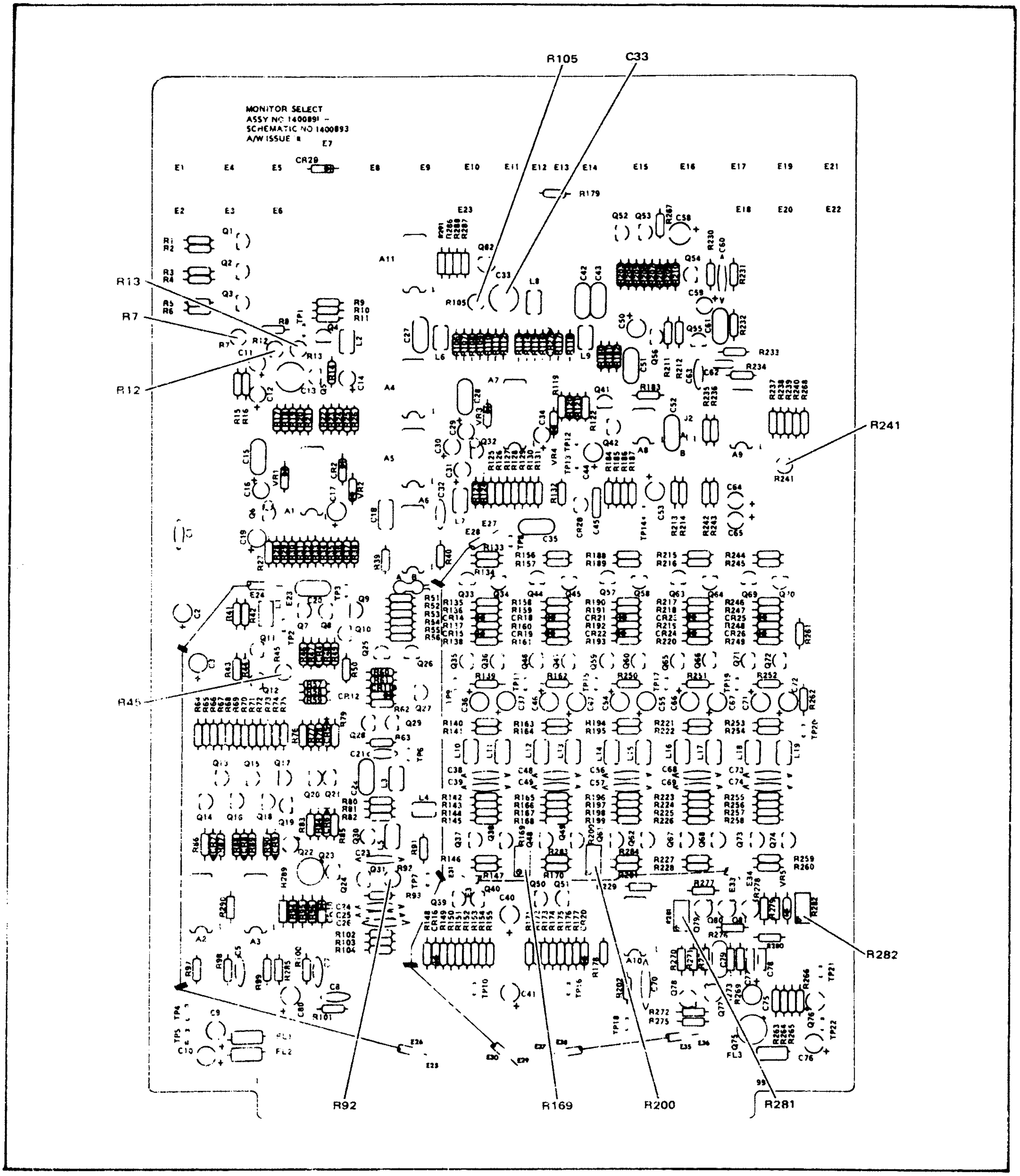


Figure 3-71. Monitor Select PWA

e. Adjust input video amplitude dc balance potentiometer R282 to make dc level of signal at TP9 equal to that of the input signal.

4. Set picture monitor amplitude gain, response and dc balance.

   a. Connect scope channel B to pin 53 (PIX MONITOR OUT).

   b. Adjust picture monitor amplitude gain R105 so signal amplitude at pin 53 equals that of the input video (unity gain).

   c. Adjust picture monitor amplitude response C33 (variable capacitor) so that the high frequency response of the signal at pin 53 matches that of the input video.

   d. Adjust picture monitor dc balance R241 to establish blanking of the pin 53 signal (channel A) at zero volts dc.

5. Set waveform monitor amplitude gain.

   a. Connect scope channel B to pin 37 (WAVEFORM MONITOR OUTPUT).

   b. Adjust waveform monitor amplitude gain R12 so that the output signal amplitude equals that of the input (unity gain).

6. Set demodulator video gain.

   a. Connect scope channel A to pin 67 (DEMOD OUT).

   b. Press monitor select switch DEMOD VID (leave VIDEO depressed).

   c. Adjust demod video gain R169 to achieve unity gain (amplitude at pins 67 and 37 are equal). Note that R169 is a fixed resistor on some version boards.

7. Set video out gain.

   a. Connect scope channel A to pin 71 (VIDEO OUT).

   b. Adjust video out gain R200 so that the output signal amplitude equals that of the input (unity gain).

8. Set up waveform monitor.

   a. Turn waveform monitor dc restorer off.

   b. Adjust WFM vertical centering to place blanking at zero volts.

   c. Press CONTROL TRACK monitor select button.

   d. Place VPR in play mode.

   e. Adjust ground strobe dc level R7 so that the ground strobe is flush with the trace between the control track pulses.

   f. Adjust waveform dc position R13 to set center line trace between control track pulses at +30 IRE.

   g. Press RF ENVELOPE monitor select button.

   h. Adjust RF envelope dc position control R45 to set RF envelope at +30 IRE.

9. Set AST error amplitude.

   a. Remove VPR power and extract AST Servo PWA from slot 9. Place PWA on extender and insert PWA/extender into slot 9. Restore VPR power.

   b. Press AST ERROR button on monitor select PWA.

   c. Place VPR in still frame play mode.

d. Adjust AST error amplitude control 9R24 (on AST Servo PWA) to obtain a ramp on the WFM of approximately 50 IRE amplitude.

10. Set RF envelope amplitude.

a. Press RF ENVELOPE button on monitor select PWA.

b. Place VPR in normal play mode.

c. Adjust RF nevelope amplitude control R92 (Monitor Select PWA) to set RF amplitude at approximately 25 IRE amplitude.

11. Restore system to normal.

a. Remove VPR power.

b. Extract Monitor Select PWA and AST Servo PWA with extenders from their slots, separate from extenders and restore PWA's to their appropriate slots.

3-132. Component Replacement Procedures

Use procedures of this section to replace mechanical components and electrical assemblies of the VPR-2B.

2-133. Scanner Head Replacement.

CAUTION

IF AN AST HEAD IS REPLACED, THE AST SERVO PROCEDURE PARAGRAPH 3-63 *MUST* BE PERFORMED AFTERWARD.

Use these instructions to replace a head within the scanner assembly. Scanner head part numbers are given in Table 3-8. Figures 3-73 and 3-74 show the locations of the head assemblies and types of head securing devices used. The three video-type heads are secured with a bridge clamp. The three sync-type heads are secured using a connector brace. A lip is provided on the bridge clamps and the connector braces to support the signal connectors. This support counteracts centrifugal force resulting from scanner rotation.

1. Remove power from the VPR.
2. Remove tape from the scanner assembly.
3. Remove scanner top cover by removing three cross-head screws.

NOTE

It is suggested that the scanner be rotated clockwise only, to prolong slip-ring brush life.

4. To simplify head changing, rotate the scanner clockwise so that the head to be changed points away from the entrance and exit guide.
5. Being careful not to pull on connector wires, carefully disconnect the head connector by pulling the connector straight up from the scanner.
6. To change a video record, reproduce, AST reproduce, or erase head, perform the following steps. (To change a sync head, proceed to step 7.)

   a. Turn the center No. 10 slot-head screw of the bridge clamp counterclockwise until it reaches a stop (about one-half turn, Figure 3-73).

Table 3-8. Scanner Head Part Numbers

DESCRIPTION	PART NO.	REMARKS
Video erase – 525 Video erase – 625	1401160 1401165	
Video record/reproduce – 525 Video record/reproduce – 625	1401161 1401166	Same type head is used in record and reproduce positions (non-AST VPR).
Video AST (reproduce) – 525 Video AST (reproduce) – 625	1401162 1401167	
Sync erase – 525 Sync erase – 625	1401163 1401168	
Sync record/reproduce – 525 Sync record/reproduce – 625	1401164 1401169	Same type head used in record and reproduce positions.
Sync dummy head	1401170	Same type dummy head is used in erase, record, and reproduce positions.

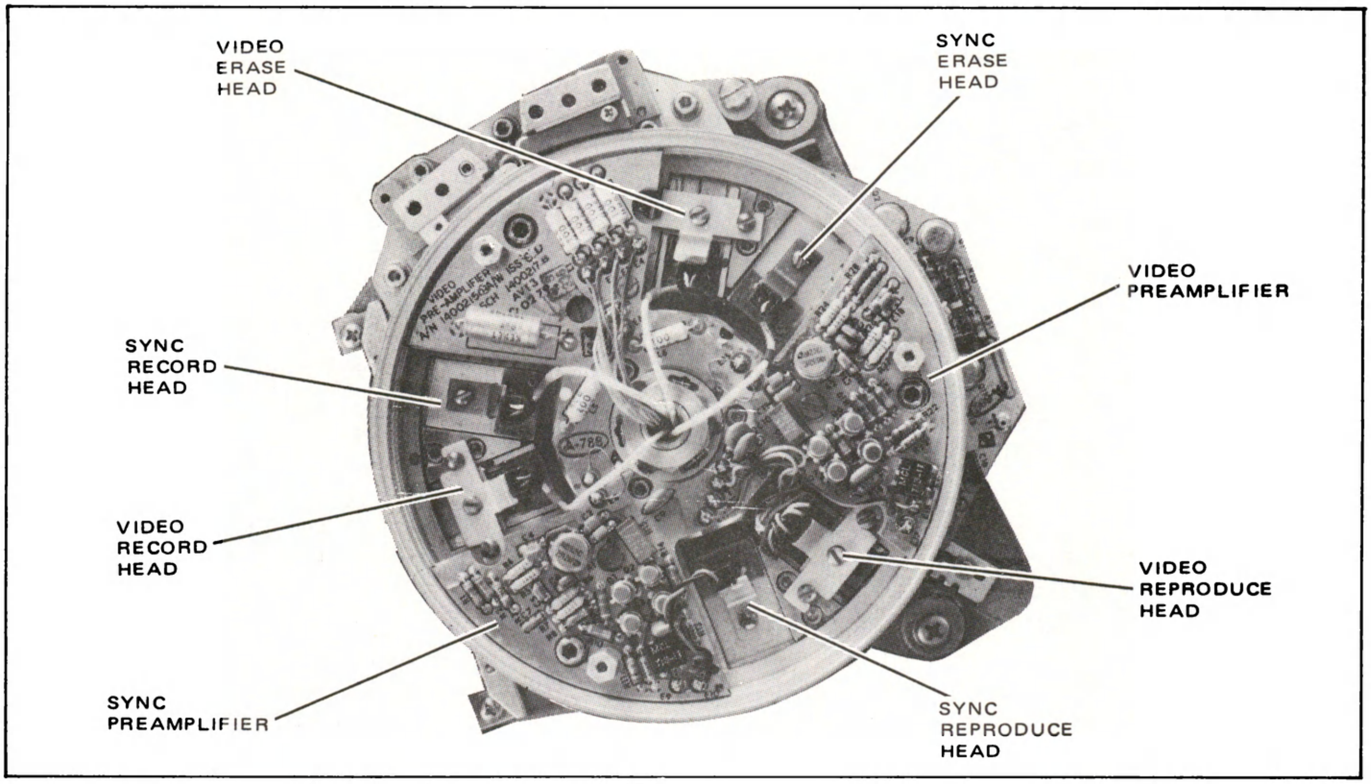


Figure 3-72. Scanner Heads and Preamplifier PWA Locations

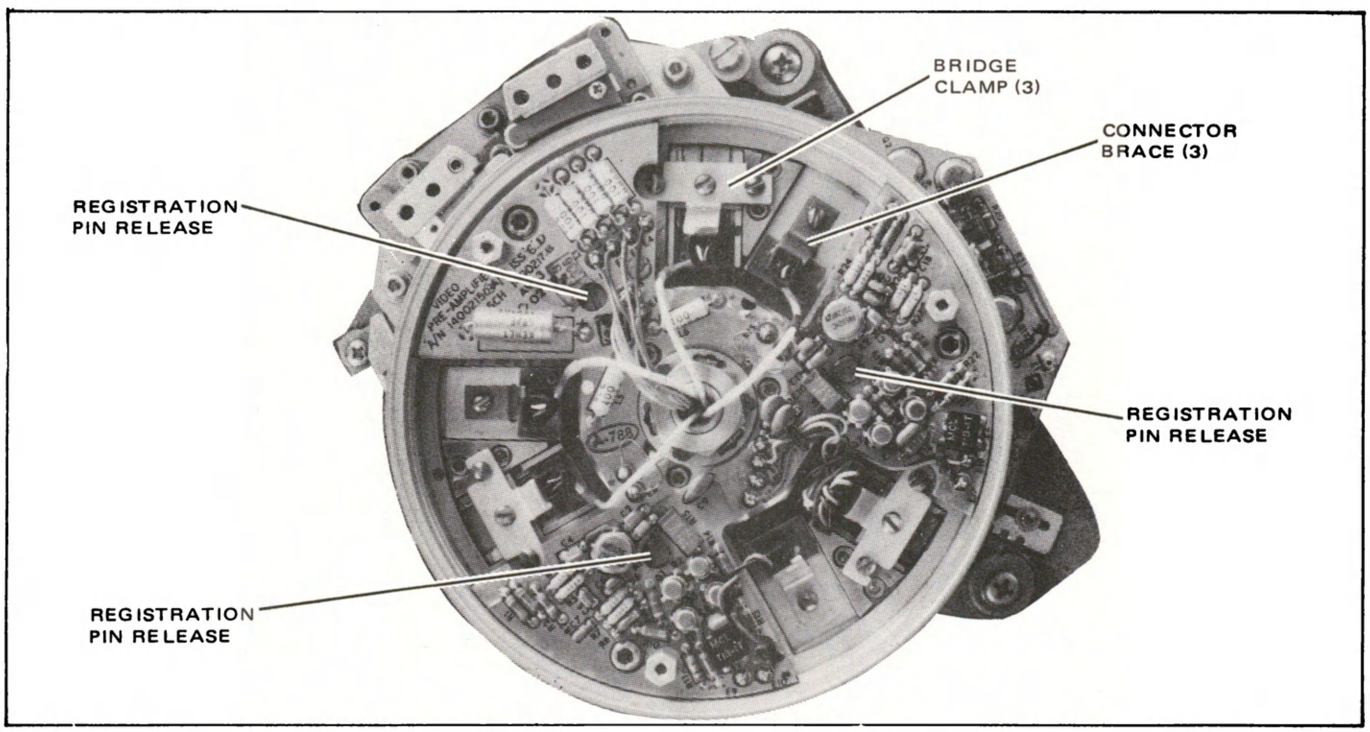


Figure 3-73. Scanner Registration Pin Release

b. Turn the two outer No. 4 slot-head screws of the bridge clamp two turns counter-clockwise so that the bridge may be slipped out from under the two securing screws.

c. Access to the registration-pin head lock is through a hole in the Preamplifier PWA that is nearest the head being changed (Figure 3-73). Turn the head lock counter-clockwise until it stops (about one-fourth turn) to retract the registration pin from the head.

d. Carefully slide the head back toward the center of the scanner casting and raise the rear end of the head assembly while removing the head from the scanner.

e. Check that there is no dirt or lint on the scanner (use clean compressed air if available). Carefully slide the new head in place into the scanner while taking care not to hit the head tip. Slide head all the way forward toward the periphery of the scanner.

f. Lock the head against the registration pin by turning the registration-pin head lock clockwise until slot points approximately toward center of scanner.

g. Slide the bridge clamp under the two bridge securing screws and then tighten the two screws.

h. Tighten the center slot-head screw of the bridge clamp just enough to lock the head in place (do not over-tighten the screw).

i. Align the head connector with the head connector pins and gently insert the head connector.

7. To change a sync record, reproduce, or erase head, perform the following steps:

   a. Unscrew the No. 4 slot-head screw that secures the head and connector brace to the scanner casting. Remove the brace and screw.

   b. Access to the registration-pin head lock is through a hole in the Preamplifier PWA that is nearest to the head being changed (Figure 3-73). Turn the head lock clockwise until it stops (about one-fourth turn) in order to retract the registration pin from the head.

   c. Carefully slide the head back toward the center of the casting and raise the rear end of the head assembly while removing head from the scanner.

   d. Check that there is no dirt or lint on the scanner (use clean compressed air if available). Carefully slide the new head in place into the scanner while taking care not to hit the head tip. Slide head all the way forward toward the periphery of the scanner.

   e. Lock the head against the registration pin by turning the registration-pin head lock counterclockwise until slot points toward center of the scanner.

   f. Reinstall the No. 4 slot-head screw and the connector brace removed in step 7a. Tighten the screw just enough to lock the head in place (do not overtighten the screw).

   g. Align the head connector to the head connector pins and gently insert the head connector.

CAUTION

DO NOT APPLY THE HEAD DATA GUMMED LABEL FROM THE HEAD BOX TO THE ROTATING SCANNER AS THIS WILL CAUSE THE SCANNER TO BE OUT OF BALANCE. APPLY THE LABEL TO THE INSIDE OF THE PIVOTING LOWER CLAMSHELL COVER.

8. Reinstall the scanner top cover removed in step 3 so that the head-identifying decal (ERASE – PLAY – RECORD) is aligned with the respective head assembly. Do not over-tighten the three screws that secure the cover to the scanner casting.

3-134. Longitudinal Head Replacement. The left and right longitudinal head assemblies are shown in Figure 3-74. An entire assembly or individual head stack may be replaced. The head stack position on the head assembly casting is fixed by a pin that mates with a hole in the head stack. Because of the precision mounting surface, no adjustment for azimuth is required. However, after a head stack is changed, perform the appropriate electrical alignment procedure for optimum performance.

3-135. *Left Longitudinal Head Assembly.* Change the left longitudinal head assembly or an individual head stack on the assembly:

1. Remove tape and reels from transport.
2. Turn VPR power OFF.
3. Remove transport trim and audio head cover to gain access to the video/sync erase head assembly and associated connectors.
4. Disconnect associated head cable connectors located on left side of tape transport.
5. Remove three 6-32 socket-head screws (assembly securing screws) and washers (Figure 3-74). Remove left longitudinal head assembly from transport.
6. To change the head stack:
   a. Label and then unsolder head stack leads using a small pencil-type low-wattage soldering iron.
   b. Remove head stack by removing screw or nut at bottom of head assembly casting.
   c. Before replacing head stack, clean bottom of head stack and head mounting surface with head cleaner. Secure head with a single screw or nut as applicable. Check that head is mounted flush to base plate.
   d. Observing correct lead labels, resolder head stack leads using a small pencil-type low-wattage soldering iron.
7. Reinstall longitudinal head assembly on transport. Secure with three 6-32 socket-head screws and washers removed in step 5. Before tightening screws, press head assembly casting against both alignment pins shown in Figure 3-74.
8. Reconnect cable connectors disconnected in step 4.
9. Verify *Helical Scan Test and Alignment,* paragraph 3-38.

3-136. *Right Longitudinal Head Assembly.* To change the right longitudinal head assembly (Figure 3-74) or an individual head stack on the assembly, proceed as follows:

1. Remove tape and reels from the transport.
2. Turn VPR power OFF.
3. Remove transport trim and audio head cover to access audio head assembly and associated connectors.
4. Disconnect associated head cable connectors located on left side of tape transport.

NOTE

The head assembly rests flush against the stop which is mounted to the flutter idler (Figure 3-74). Do not loosen the screw in the stop's center. The assembly is restored flush against the stop upon being reinstalled.

5. Remove three 6-32 socket head screws and washers (Figure 3-74) securing right longitudinal head assembly to casting. Remove the head assembly.
6. To change an individual head stack, proceed as follows:
   a. Label and then unsolder head stack leads using a small pencil-type low-wattage soldering iron.

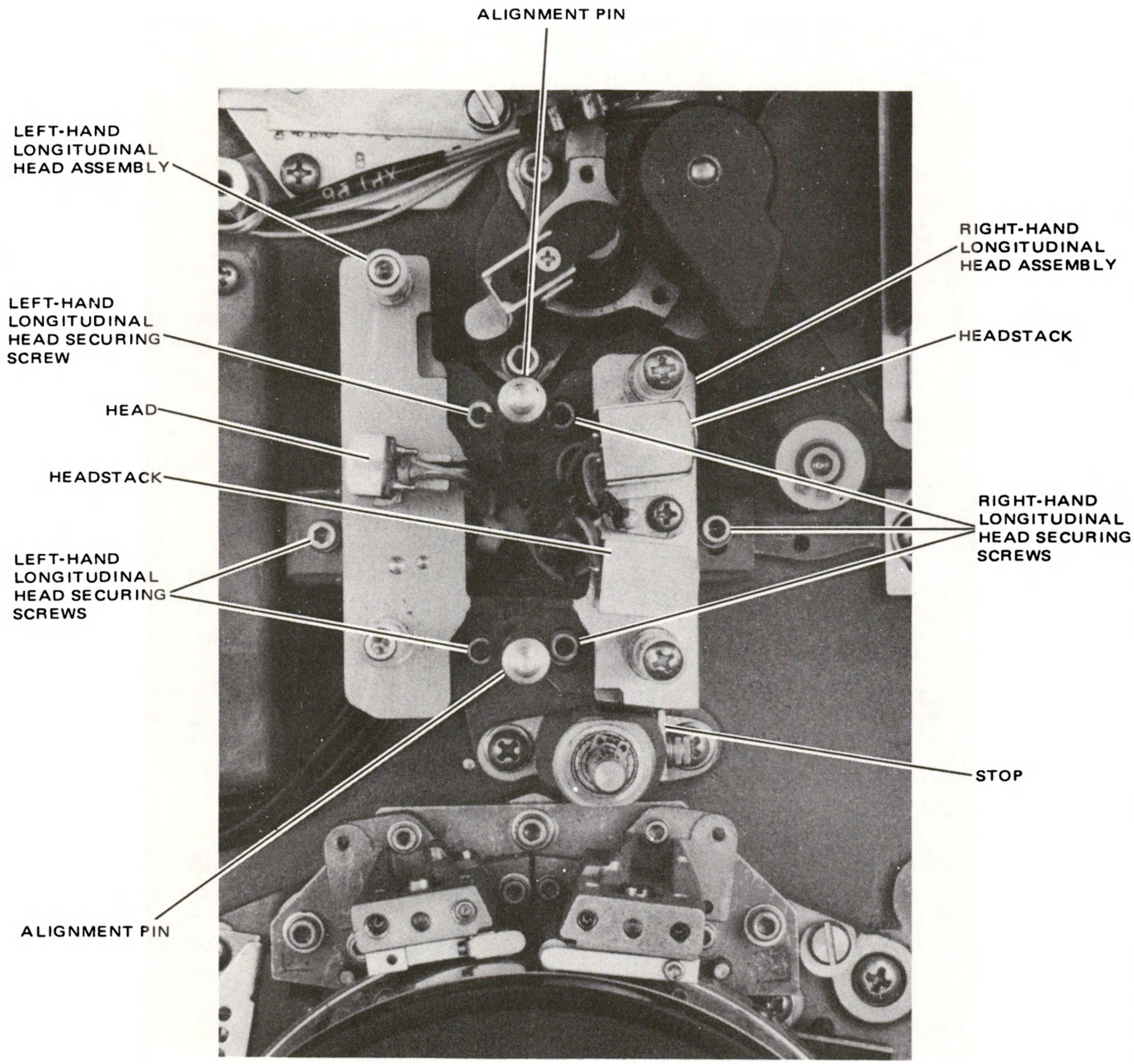


Figure 3-74. Longitudinal Head Assemblies

b. Remove head stack by removing screw or nut at bottom of head assembly casting.

c. Before replacing the head stack, clean bottom of head stack and head mounting surface with head cleaner. Secure head with a single screw or nut as applicable. Check that the head is mounted flush to the base plate.

d. Observing identifying labels, resolder head stack leads using a small pencil-type low-wattage soldering iron.

7. Reinstall right longitudinal head assembly on transport. Secure with three 6-32 socket-head screws and washers removed in step 5. Before tightening screws, press head assembly casting against both the stop and the alignment pins shown in Figure 3-74.

8. Reconnect cable connectors disconnected in step 4.

9. Reinstall trim panels.

10. If an audio or erase head stack was changed right-hand longitudinal assembly, perform the *Audio Signal System* procedure beginning with paragraph 3-94. If the right longitudinal head assembly or the head stack containing the control-track heas was changed, perform the *Control Track Head Phase Adjustment* procedure (paragraph 3-45) and the *Helical Scan Alignment,* paragraph 3-38 in addition to the *Audio Signal System* alignment procedure.

3-137. Timer Idler. Use these instructions to replace the timer idler bearings or optical switch PWA.

3-138. *Timer Idler Bearing Replacement.* The timer idler roller contains an upper and a lower ball bearing assembly which are permanently lubricated. If bearing replacement is necessary, it is best to replace bearings (Ampex Part No. 120-063) as a pair. Proceed as follows:

1. Remove hex-socket cap screw and internal tooth lock washer (Figure 3-75) securing cap to timer idler shaft.

2. Remove timer idler cap, wavy washer, and shim washer lying beneath the cap.

3. Carefully lift roller (with upper bearing attached) from the shaft (Figure 3-76). Discard bearing.

4. Remove optical tachometer connector J3/P3.

5. Remove three Phillips flat-head screws securing timer idler flange to idler stanchion (Figure 3-77).

6. Remove flange from stanchion. Carefully lift side of flange opposite optical switch assembly, and move flange sideways to free optical switch from counter disc. Lift flange from shaft.

7. Remove retaining ring (Figure 3-78) retaining lower ball bearing from the timer idler shaft.

CAUTION

THE COUNTER DISC MUST BE REPLACED (LATER) RIGHT-SIDE UP. BEFORE REMOVING DISC, PLACE A PIECE OF LOW-TACK TAPE ON TOP OF IT LABELED "UP"; OR MAKE A SMALL PENCIL MARK. THE DISC IS FRAGILE – USE GREAT CARE. FIGURE 3-79 DISPLAYS CORRECTLY INSTALLED DISC.

8. Carefully remove lower bearing along with counter disc (Figure 3-78) and backing washer immediately below counter disc. Do not remove the hardware below the bearing consisting of two shim washers and grating secured by a cross-recessed panhead screw.

9. If the counter disc is attached to the lower bearing, free the counter disc from the bearing by slightly bowing the disc so it slides off bearing. Discard bearing.

10. Perform the following steps on a clean workbench surface:

a. Install backing washer on new lower bearing.

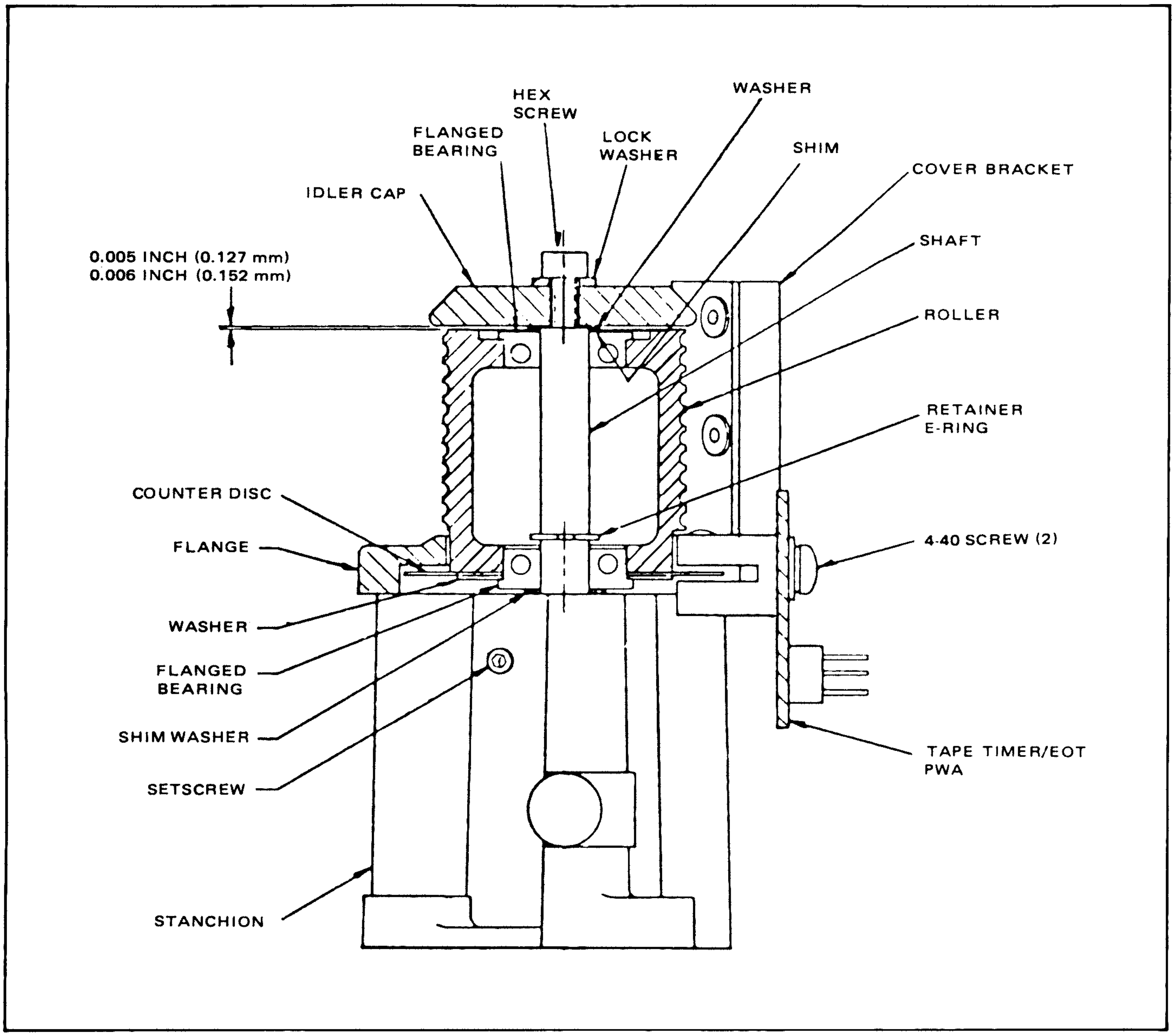


Figure 3-75. Cutaway View of Timer Idler Assembly

b. Install counter disc as follows. The counter disc must be right-side up. Figure 3-78 shows correct installation and proper pattern (and phase relationship) of inner/outer disc holes. Bow the counter disc slightly while placing disc on lower bearing so that the three lobes on the disc inner diameter are deformed evenly. Use the counter roller as a tool to press the counter disc down against the backing washer. If tape level was installed on disc, remove tape gently along with any adhesive residue.

11. Install new lower bearing (backing washer and disc) on timer idler shaft (inner race of the bearing rests against the two shim washers that were left on the shaft in step 8).

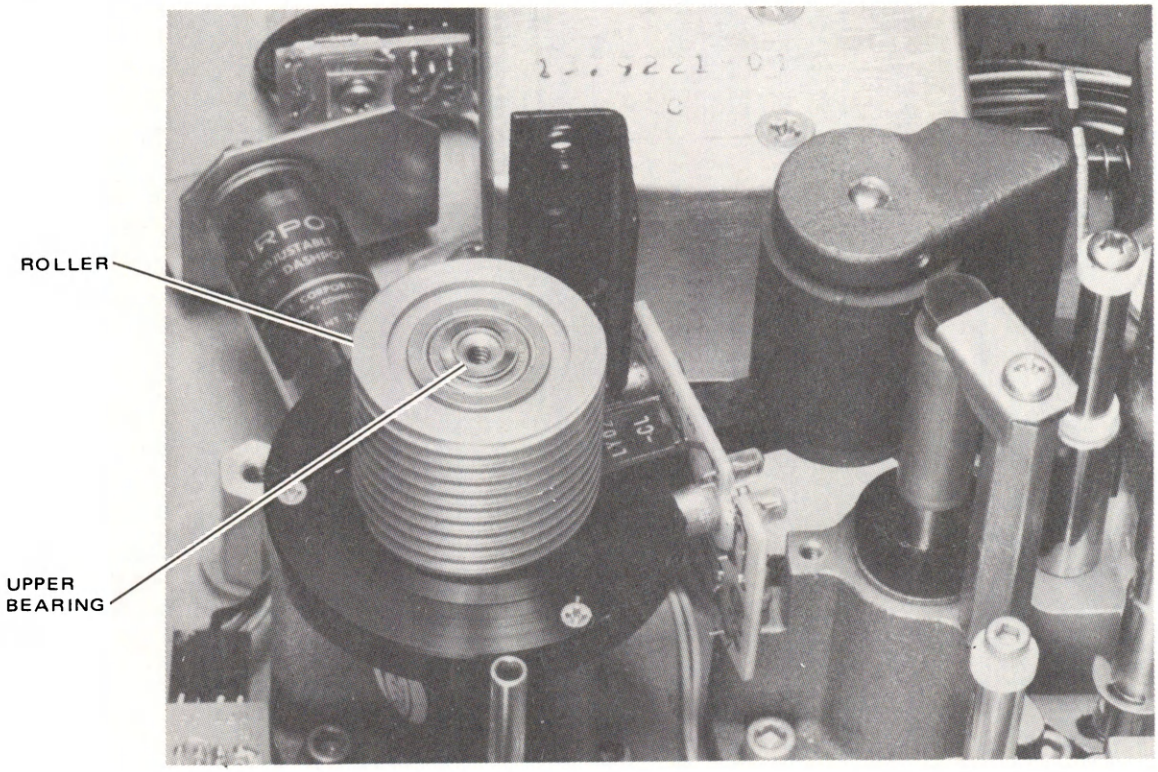


Figure 3-76. Timer Idler Roller Removal

12. Reinstall retaining ring, removed in step 7, on idler shaft.

13. Carefully reinstall flange (three cross-head flat screws) removed in step 6 while being careful not to bend copper grating or counter disc. Grating and disc fit between halves of the optical switch. The tip of the grating rests on the lower face of the optical switch.

14. Secure flange to idler stanchion with three Phillips flat-head screws removed in step 5.

15. Reinstall roller onto lower bearing.

16. Install new upper bearing onto shaft and into center of roller.

17. Install shim washer on top of upper bearing (must be centered and seated).

18. Install wavy washer on top of shim washer. The washer must be centered on the shaft and not slip during cap replacement.

19. Using care not to dislodge wavy washer, install timer idler cap on end of shaft and secure to shaft with internal tooth lock washer and hex-socket cap screw removed in step 1.

20. Manually spin roller to check that roller spins freely. The wavy washer applies the proper bearing preload when a gap 0.005 to 0.006 inch (0.127 to 0.152 mm) exists between the timer idler cap and the roller as shown in Figure 3-75. This gap dimension should not change when performing the idler disassembly procedure. If gap adjustment is required, proceed as follows:

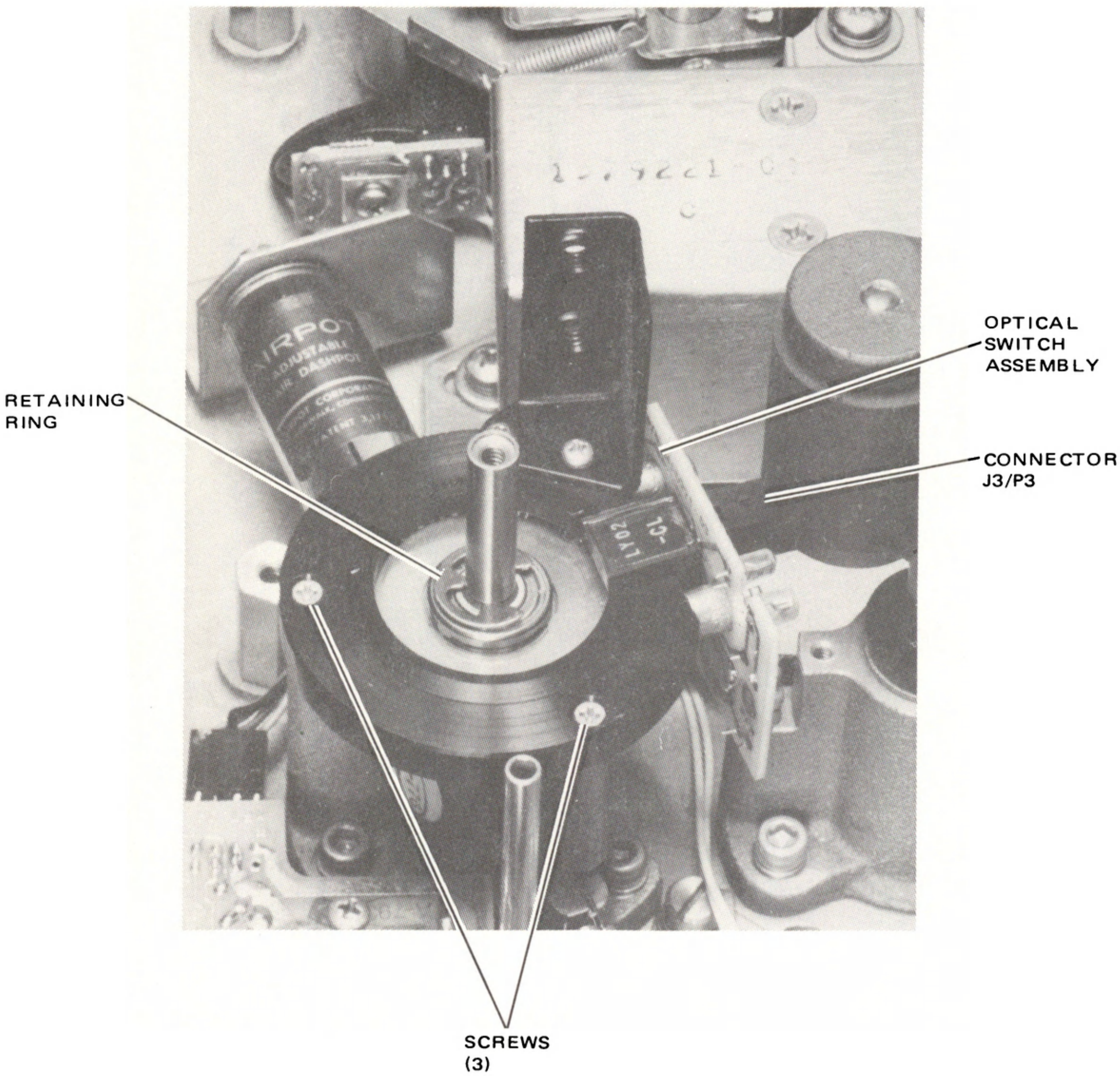


Figure 3-77. Timer Idler Flange Removal

a. Loosen two hex-socket setscrews securing timer idler shaft to stanchion (Figure 3-75).

b. Use a feeler gauge and move the cap (and shaft) to obtain a 0.005 to 0.006 inch (0.127 to 0.152 mm) gap (Figure 3-75).

c. Retighten setscrews loosened in step 20a.

d. Again check for free movement of roller.

3-139. *Optical Switch PWA Replacement.* Three optical switch elements (Figure 3-79) reside on

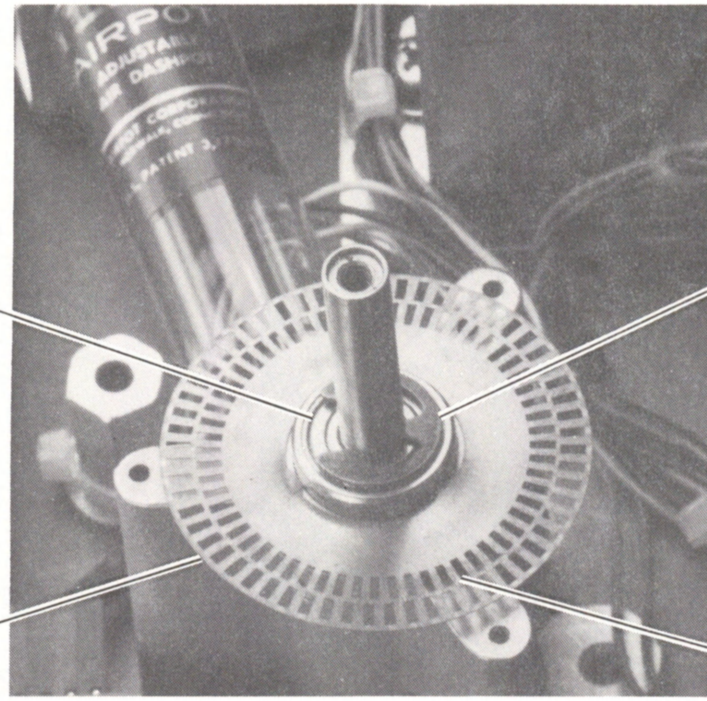


Figure 3-78. Counter Disc Removal

the Optical Switch PWA; switch matched pair Q1 (Ampex Part No. 581-454) and switch A1 (Ampex Part No. 581-625). The Optical Switch PWA is complete, and connects to the transport via connector J3/P3.

Proceed as follows:

1. Remove transport trim to access optical switch assembly mounted on timer idler assembly, and connect J3/P3.

2. Disconnect plug P3 from jack J3 (Figure 3-79).

3. Remove two Phillips pan-head securing screws to free optical switch assembly. Remove assembly.

4. Remove the defective element (assembly A1, LED light source Q1A or photo-darlington Q1B). Carefully desolder it from the board. Note device/pin orientation for correct installation of new device.

5. Insert the replacement component in the board. Solder new element in place – use minimal heat and exposure time since solder-through is not required.

6. Replace the optical switch assembly in the transport and replace two screws removed in step 3.

7. Reconnect connector plug 3 to jack 3 (removed in step 2).

8. Verify optical switch assembly operates normally:

   a. Thread tape on transport.

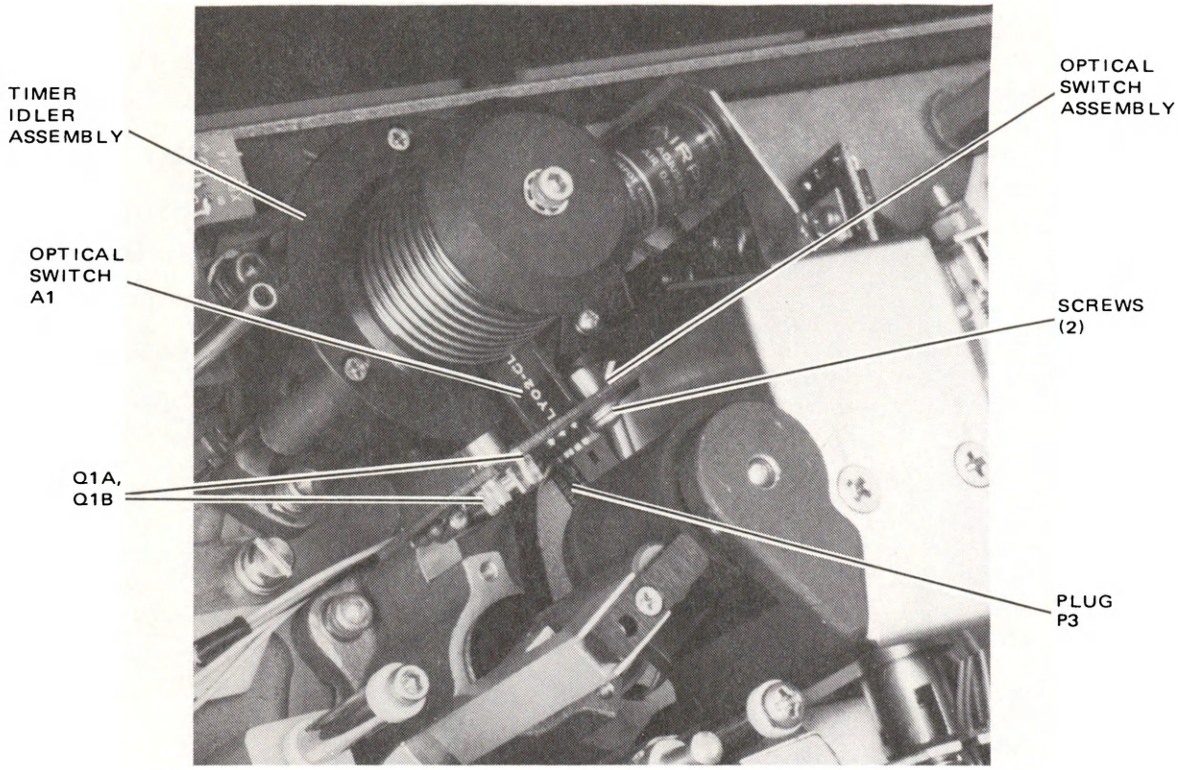


Figure 3-79. Timer Idler Optical Switch Assembly

b. Place system in fast forward and verify tape timer display counts upward.

c. Place system in rewind (REV) and verify tape timer display counts downward.

9. Unthread tape and remove both reels from machine.

10. Remove system power.

11. Replace transport trim removed in step 1.

3-140. Idler Assembly Replacement. The idler assembly (Figures 3-80 and 3-81) is the first transport element encountered by tape as it exits the supply reel. Its purpose is to turn the tape around to face in the right direction, and to provide initial tape guiding. The idler assembly should be replaced as a complete unit only, and not parts thereof. This is because critical perpendicular alignment of the idler assembly as a unit as achieved at the factory cannot be duplicated in the field. A worn idler assembly may manifest itself as flutter or irregular initial tape guiding. The idler assembly contains no tachometer or other electrical element.

Adjustment to idler hub elevation (with respect to other tape path elements) may be done in the field, but only after certain verification that the tape being used when evaluating idler performance is new or in good shape; the supply turntable height is correct (see paragraph 3-149 step 15 to

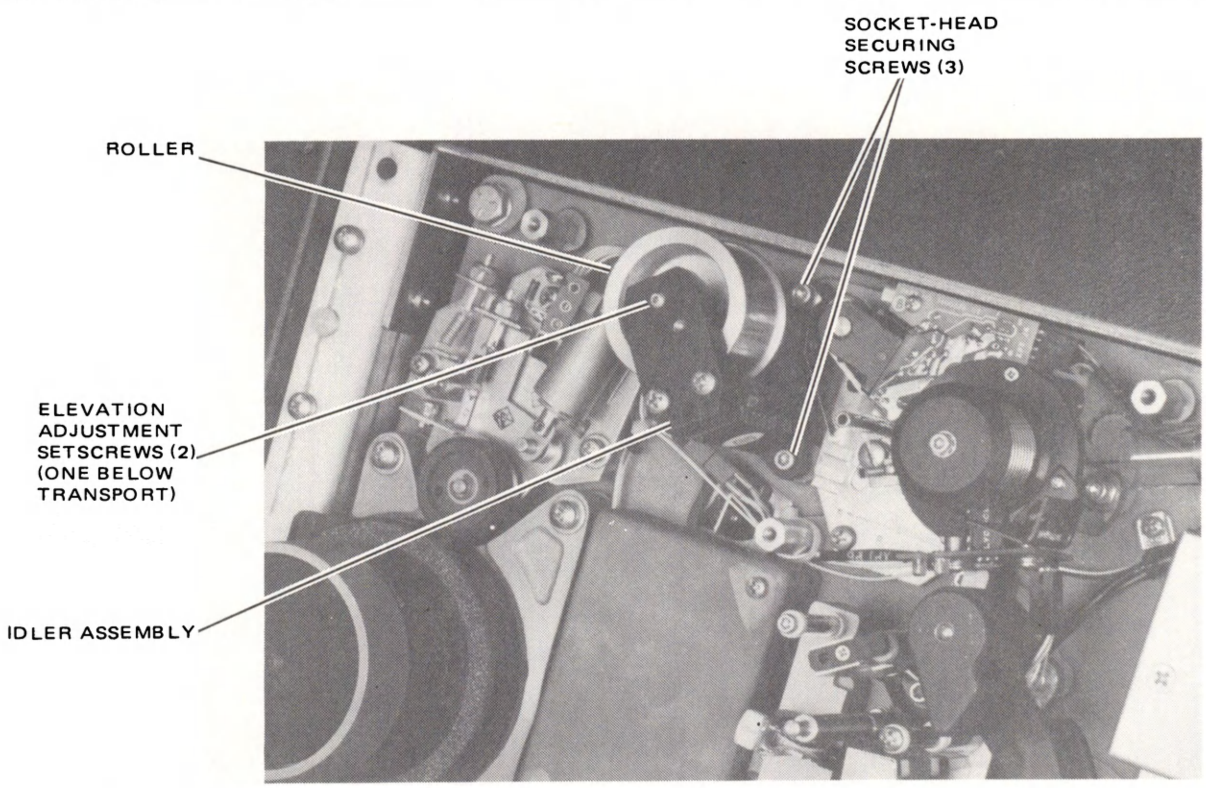


Figure 3-80. Idler Assembly (Turnaround) Removal and Adjustment

measure turntable height); and examination during forward tape movement shows the top or bottom idler hub ridge contacting or interfering with moving tape. The specification for roller elevation is expressed in Figure 3-82. A new replacement idler assembly should not require such adjustment when installed. The *Idler Roller Elevation Adjustment Procedure* immediately follows this procedure. Replace the idler assembly as follows:

1. With VPR power off, remove the left-hand transport trim panel.

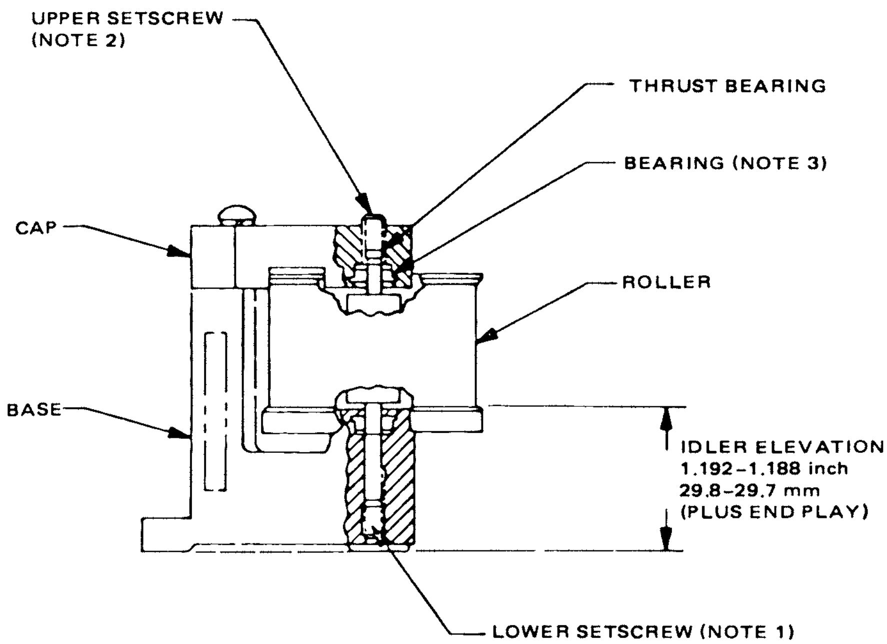
2. Using a socket-head wrench, remove the three socket-head screws securing the idler assembly base to the transport casting (Figure 3-81). Using care not to drop spacers which are under the idler assembly, remove the idler assembly (and spacers).

3. Before installing new idler assembly, clean the base of the new idler assembly and the transport mounting surface using isopropyl alcohol.

4. Install new idler assembly with spacers onto transport. Install the three socket-head screws removed in step 2 and snug them down finger tight. Move the idler assembly slightly to ensure that it is squarely seated and flush. Tighten each screw (with the wrench) little by little until they are all secure and tight.

5. Replace trim panel removed in step 1.

3-141. *Idler Roller Elevation Adjustment Procedure.* Adjustment to the idler roller elevation is indicated when transporting tape contacts or is interfered with by either the upper or lower ridge of the idler hub. However, such misalignment may be caused by incorrect turntable height, or by worn or stretched tape being used. Do not attempt the idler height adjustment before verifying correct turntable height (paragraph 3-149, step 15 or



NOTE 1: ADJUST LOWER SETSCREW TO SET FLANGE HEIGHT AS NOTED (OR AS REQUIRED).
NOTE 2: ADJUST UPPER SETSCREW TO LEAVE 0.0005/0.0015 VERTICAL END PLAY.
NOTE 3: LUBRICATING OIL AMPEX PN 087-579.

Figure 3-81. Idler Assembly, Turnaround

before evaluating idler performance using a new tape. The specified value for roller elevation appears in Figure 3-81. If idler hub height requires adjustment, proceed as follows:

CAUTION

MAKE NO ADJUSTMENTS OTHER THAN THOSE SPECIFIED BELOW. THE JACKING SCREWS IN THE TURNAROUND IDLER BASE ARE FACTORY SET USING A SPECIAL ALIGNMENT FIXTURE AND MAY NOT BE ADJUSTED IN THE FIELD.

1. Remove the back panel and fan assembly to allow access to the bottom height adjustment screw. Remove left-hand trim panel (top of machine) if not already off.

2. Determine the direction and the approximate quantity of adjustment required. If the top ridge of the hub contacts tape, the hub must move up – proceed to step 3 below. If the bottom ridge of the hub contacts tape, the hub must move down – proceed to step 4 below.

3. Increase idler roller elevation. Proceed as follows:

   a. Using a round-head Allen wrench, loosen the top height adjustment setscrew, shown in Figure 3-81. One complete turn of the screw equals 31.25 mils (0.781 mm) of elevation allowance.

b. With the same tool, tighten the lower elevation setscrew approximately the same amount that the top screw was loosened. Do not force the screw beyond this point as it will bind the thrust bearings and roller. The bottom adjustment setscrew is accessed from below the transport through a hole in the transport casting. Figure 3-82 shows hole location.

c. Once the desired elevation is reached, set the lower setscrew to allow 0.5 to 1.5 mils (0.0127 to 0.0381 mm) of end play as indicated in Figure 3-81. Proceed to step 5.

4. Decrease idler roller elevation. Proceed as follows:

   a. Using a round-head Allen wrench, loosen the bottom height adjustment screw. This screw is accessed from below through a hole in the casting. Figure 3-82 shows the location of this hole. One complete turn of the screw equals 31.25 mils (0.781 mm) of elevation decrease.

   b. Tighten the top elevation setscrew approximately the same amount that the bottom setscrew was loosened. Do not force the screw beyond this point as it will bind the thrust bearings and roller.

   c. Once the desired elevation is reached, set the lower setscrew to allow 0.5 to 1.5 mils (0.0127 to 0.0381 mm) of end play as indicated in Figure 3-81. Proceed to step 5.

5. After roller elevation is adjusted, spin the roller rapidly with the fingers. Verify that it spins freely with no visible friction or wobble (looseness). Listen closely (while spinning) to be sure that it is nearly silent. It should turn for some time and not stop short.

6. Thread a reel of new tape on the transport. Initiate play mode and observe the tape. It should ride at or near the center of the idler roller (hub), and do so in a stable fashion (not wander). Shuttle the tape forward and backward and verify that it continues to guide in a reliable manner.

7. Remove tape from machine and remove VPR power. Replace fan assembly, back cover, and left-hand trim panel removed in step 1.

3-142. Capstan Brake Assembly Replacement. The capstan brake assembly should normally not require replacement. If the capstan brake assembly must be removed for repair or replacement, remove it using the procedure below:

1. Remove VPR power.

2. Remove VTR cabinet back panel and fan assembly 1 (front panel trim removal is not required).

3. Disconnect capstan brake assembly power connector P1 (Figure 3-83) and remove mounting screw holding the connector pc board.

4. Loosen capstan shaft elevation screw lock nut and back out the screw (counterclockwise) about five or six turns. This action lessens the likelihood that the thrust bearing will fall out during brake assembly removal.

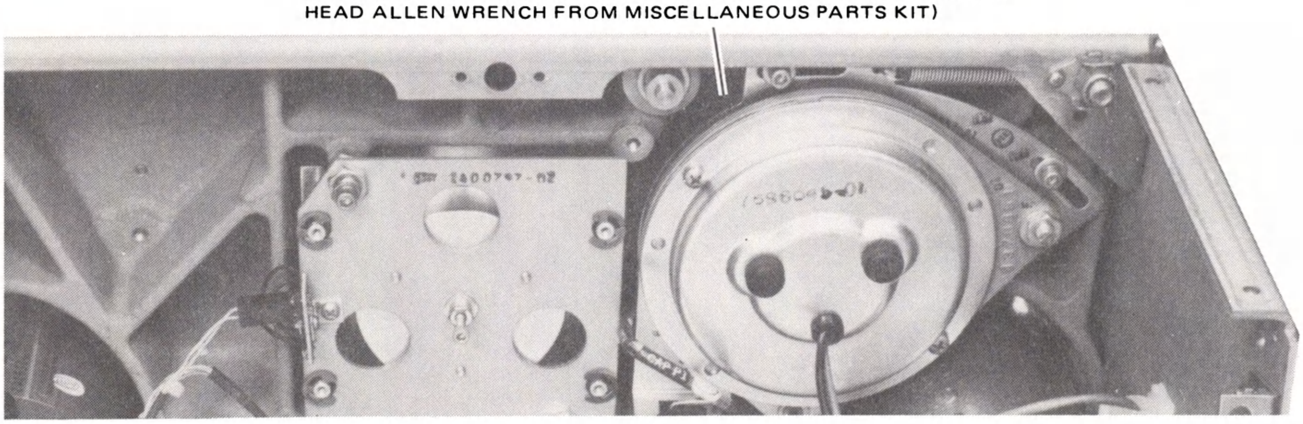


Figure 3-82. Idler Assembly Hub Elevation Adjustment

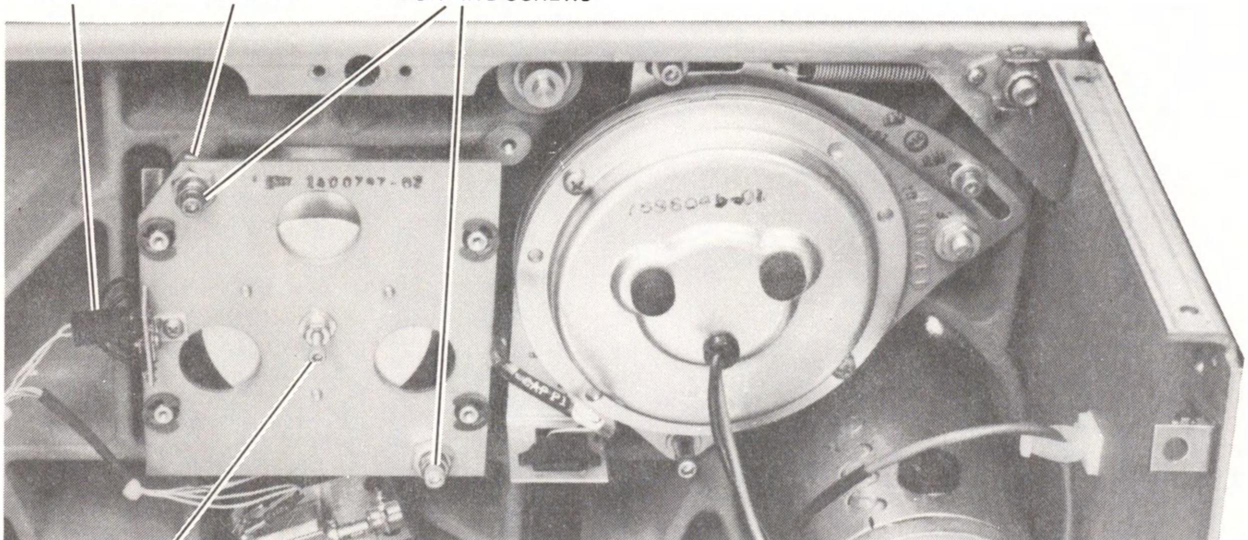


Figure 3-83. Capstan Brake Assembly Removal

5. Remove two hex-socket cap screws (Figure 3-84) securing capstan brake assembly; remove the unit, be alert for the thrust bearing (nylon piece) which may fall out.

NOTE

Capstan shaft elevation and flywheel positioning must be correct prior to capstan brake assembly replacement. If capstan shaft elevation has been altered or is not known, perform Capstan Shaft Replacement procedure, Paragraph 3-152 steps 8 through 12 before proceding with the procedure below.

6. Install new bottom thrust bearing (Ampex Part No. 720-6061) into its location inside the Capstan Brake Assembly. Retain bearing with a small amount of grease. Ampex Part No. 087-010 — (silicone grease, Dow Corning 11 or equivalent. Back out capstan positioning screw sufficiently to allow thrust bearing to bottom.

7. Mount Capstan Brake Assembly to transport using screws removed in step 5; do not tighten.

8. Establish 0.040 to 0.050 inches (1.00 to 1.25 mm) clearance between the top side of the solenoid housing and the cork pad on the brake plate. With capstan brake de-energized, proceed as follows:

   a. Insert the brake gauge bracket (Ampex Part No. 1400532) between brake coil housing and brake plate to measure clearance. Measure at three points equally spaced around circumference to ensure uniform gap all around.

   b. If clearance measured is not correct, loosen the two brake assembly jam nuts and adjust mounting bolts to achieve clearance required — tighten jam nuts.

   c. With fingers, move the brake plate all around to verify that it moves freely and does not bind at the guide posts.

   d. Try to turn the flywheel to verify that the brake is on, and that the capstan cannot be rotated except with excessive force.

9. Establish thrust wand assembly preload. Proceed as follows:

a. Loosen the No. 6 cap-head screw securing the thrust wand assembly to the stanchion (Figure 3-84) and remove thrust wand assembly.

b. Install capstan top gauge bracket (Ampex Part No. 1400452) onto stanchion using a No. 4-40 X 0.312-inch screw. (Figure 3-85).

c. Loosen lock nut and adjust capstan positioning screw such that the top ball of the capstan shaft just contacts the gauge bracket (this sets capstan elevation at 1.80-inches above stanchion). Tighten lock nut.

d. Remove capstan top gauge bracket (and cable clamp from stanchion if present).

e. Replace thrust wand assembly. Observe that the thrust wand deflects approximately 0.020 inches (0.5 mm) after mounting screw is tightened.

10. Position top oil slinger washer to approximately 0.060 inches (1.5 mm) from lower bearing (washer must not touch bearing).

11. Reconnect capstan brake assembly connector P1 disconnected in step 3.

12. Manually rotate capstan and observe capstan pulley; verify that the belt stabilizes and runs in the approximate center of the hub. If required, loosen locknut and adjust pivot screw for capstan motor (Figure 3-86) to center belt on pulley. Tighten locknut.

13. Apply power and initiate capstan rotation. Observe that the belt tracks properly on the pulley. If required, readjust pivot screw. With capstan running, verify pinch roller upper edge contacts capstan shaft below the chamber on shaft. Ensure that capstan and pinch roller are clean.

14. With power removed, replace fan assembly and back panel removed in step 2.

3-143. Capstan Drive Belt Replacement. Replace the capstan drive belt and adjust belt tension and alignment.

1. Remove VPR power.

2. Remove VTR cabinet back and fan assembly (it is not necessary to remove trim panel from the front of the transport).

3. Disconnect capstan motor power connector P3 and optical switch assembly connector P1 (P1 is shown in Figure 3-86).

CAUTION

WHEN REMOVING MOTOR MOUNTING HARDWARE, SUPPORT MOTOR BY HAND SO AS NOT TO STRETCH TENSION SPRING ATTACHED TO UPPER PORTION OF MOTOR PLATE. DO NOT DROP HARDWARE INTO ELECTRONIC COMPONENTS.

4. Remove three hex-socket cap screws and washers (Figure 3-86) securing capstan motor assembly to transport casting.

5. Detach tension spring from motor mounting plate; leave other end of spring attached to post on transport casting.

6. Disengage belt from motor pulley while removing motor assembly (Figure 3-87 clarifies the operation).

7. Disconnect capstan brake assembly connector P1 (Figure 3-83).

8. Remove hex-socket cap screw (Figure 3-83) securing capstan brake assembly to transport casting.

9. Support brake assembly by hand; remove the other screw (right-side screw as shown in Figure 3-86) and remove the capstan brake assembly. (Note: Do not permit capstan shaft to come forward while capstan support plate assembly is pivoted to one side.)

10. Remove the capstan belt.

11. Clean the outside diameter of the capstan flywheel with alcohol. Remove all residue.

12. Clean the capstan motor pulley with alcohol. Remove all residue.

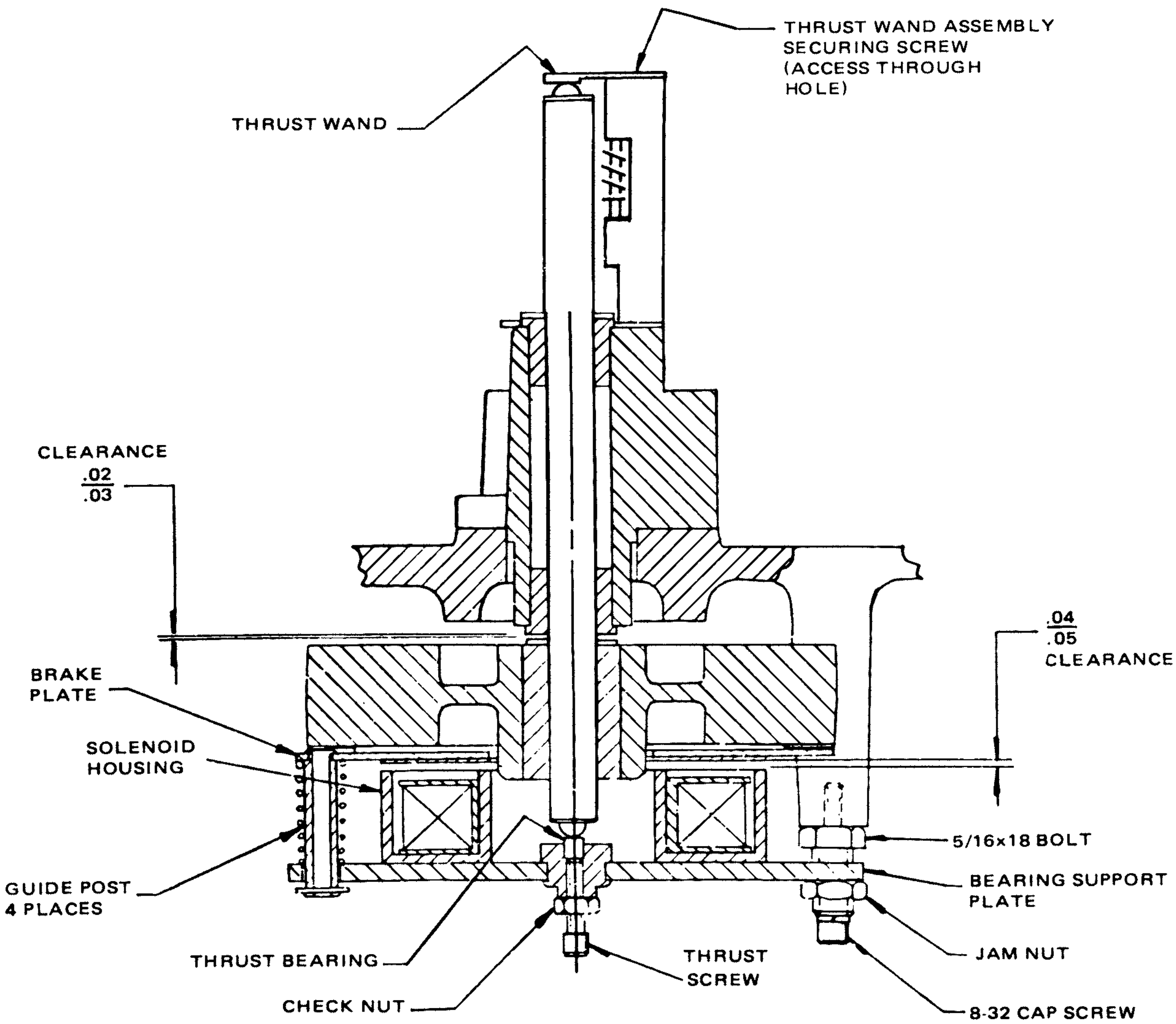


Figure 3-84. Capstan Brake Assembly

CAUTION

HANDLE MYLAR CAPSTAN DRIVE BELT CAREFULLY TO AVOID ANY FOLDS, KINKS, TEARS, OR OTHER DAMAGE THAT WILL SHORTEN BELT LIFE. IF OIL OR GREASE CONTACTS BELT, CAREFULLY CLEAN BELT WITH ALCOHOL. REMOVE ALL RESIDUE.

13. Carefully thread new belt around the capstan motor pulley. While holding motor at rear of transport, slip belt around capstan flywheel.

14. Hold the motor so that the belt remains on both pulleys. Reconnect the tension spring to the motor mounting plate.

15. Hold motor over its three mounting points on transport casting. Reinstall motor mounting

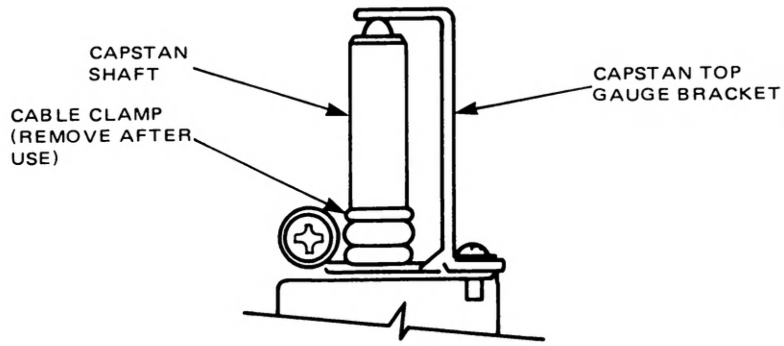


Figure 3-85. Setting Capstan Elevation/Thrust Wand Preload

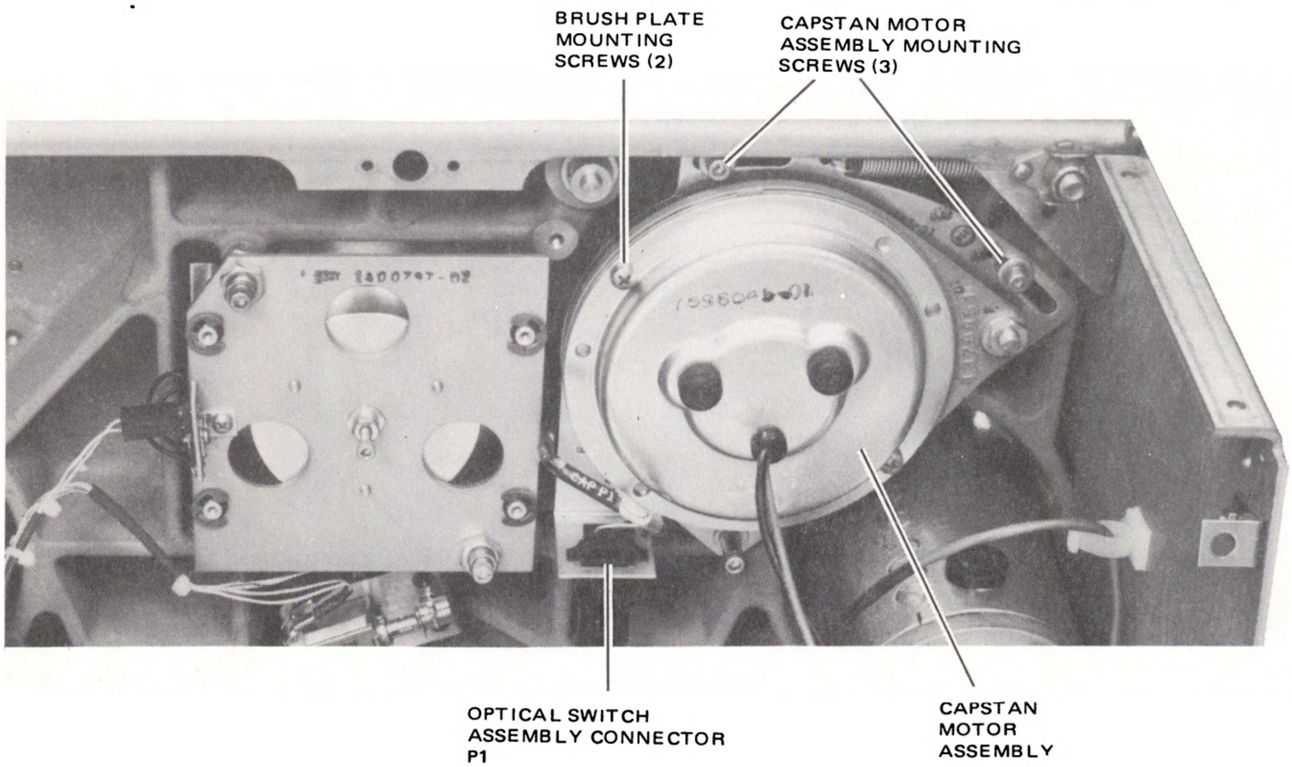


Figure 3-86. Capstan Motor Assembly Mounting

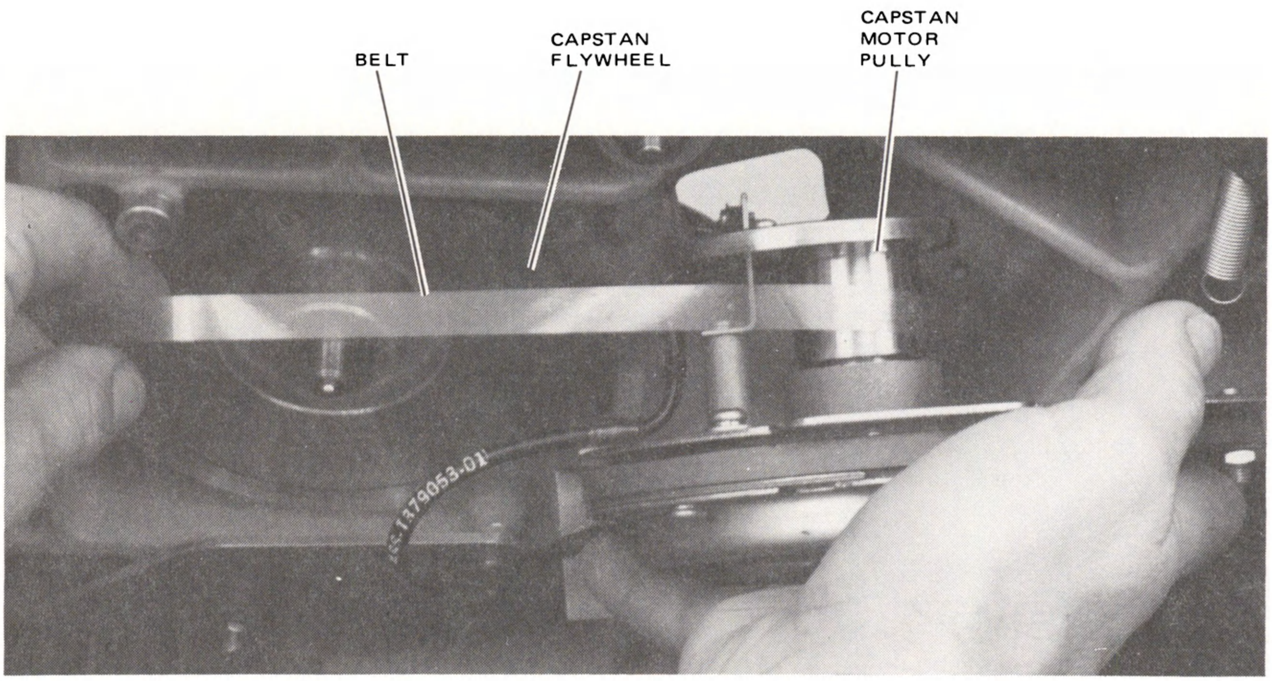


Figure 3-87. Installing Capstan Drive Belt

hardware removed in step 4. Do not firmly tighten screws yet.

16. Hold capstan brake assembly over its two mounting points on transport casting. Reinstall mounting hardware screws removed in steps 8 and 9. Tighten screws.

17. Reconnect capstan brake assembly connector P1 removed in step 7.

18. Loosen three motor mounting screws until lock washers under screws are loose.

19. Rotate the capstan flywheel until the belt assumes a stable position on the flywheel. Poke fingers through holes in brake assembly to turn flywheel.

20. Push capstan motor toward the left against the spring tension and then release to permit the spring to return the motor, and apply the correct belt tension.

21. Tighten capstan motor mounting screws (3).

NOTE

The capstan belt material is very stable. If retensioning is ever required, loosen the motor mounting screws and perform steps 20 and 21.

22. Reconnect capstan motor power connector and optical switch assembly connector removed in step 3.

23. Apply power to VPR and observe capstan belt position on the rotating flywheel. It should be centered. If the belt is not centered on the flywheel, pivot the capstan motor as follows:

   a. Loosen the pivot adjust locknut shown in Figure 3-88.

   b. Observe the rotating flywheel and adjust the pivoting adjustment screw to center the belt. Turn screw clockwise to cause belt to move toward the observer. Turn screw counterclockwise to cause belt to move away from the observer.

c. When the belt rides centered on the pulley, hold the screw in position and retighten the locknut.

24. Remove power and reinstall the back panel and the fan assembly.

3-144. Capstan Motor Assembly and Parts Replacement. Besides the complete capstan motor assembly (Figure 3-90), component parts that may require replacement are the capstan motor brushes, motor bearings, and the optical switch assembly.

3-145. *Capstan Motor Assembly Replacement.* Replace the complete capstan motor assembly:

1. Remove cabinet back panel and fan assembly (six cross-head screws). Disconnect fan connector P1.

2. Disconnect capstan motor power connector P3 and optical switch assembly connector P1.

CAUTION

WHEN REMOVING MOTOR HARDWARE, SUPPORT MOTOR BY HAND SO AS NOT TO STRETCH TENSION SPRING ATTACHED TO UPPER PORTION OF MOTOR PLATE. DO NOT DROP HARDWARE INTO ELECTRONIC COMPONENTS.

3. Remove three hex-socket cap screws securing capstan motor assembly to transport casting.

4. Detach tension spring from motor mounting plate; leave other end of spring attached to point on transport casting.

CAUTION

HANDLE MYLAR CAPSTAN DRIVE BELT CAREFULLY TO AVOID ANY FOLDS, KINKS, TEARS, OR OTHER DAMAGE THAT WILL SHORTEN BELT LIFE. EXAMINE BELT FOR SUCH DAMAGE. IF BELT IS IN POOR CONDITION, REPLACE IT. IF OIL OR GREASE CONTACTS BELT, CAREFULLY CLEAN BELT WITH ALCOHOL OR FREON TF. REMOVE ALL RESIDUE.

5. Disengage mylar belt form motor pulley while removing capstan motor assembly from transport.

6. Hold the replacement capstan motor assembly near its mounting location at rear of transport. Carefully thread mylar belt around capstan motor assembly pulley and around capstan flywheel.

7. Hold motor so that belt remains on pulley and flywheel. Reconnect tension spring to motor mounting plate.

8. Hold motor over its three mounting points on the transport casting. Reinstall motor mounting hardware removed in step 3. Do not firmly tighten screws yet.

9. With mounting screws installed in step 8 loose, rotate capstan flywheel until belt assumes a stable position on flywheel. Poke fingers through holes in brake assembly to turn flywheel.

10. Push capstan motor toward the left against the spring tension and then release to permit the spring to return the motor and apply the correct belt tension.

11. Tighten capstan motor mounting screws (3).

NOTE

The capstan belt material is very stable. If retensioning is ever required, loosen the motor mounting screws and perform steps 10 and 11.

12. Reconnect capstan motor power connector P3 and optical switch assembly P1.

13. Apply power to VPR and observe capstan belt position on the rotating flywheel. It should be centered. If the belt is not centered on the flywheel, pivot the capstan motor as follows:

a. Loosen the pivot adjust locknut shown in Figure 3-88.

b. Observe the rotating flywheel and adjust the pivot adjustment screw to center the belt. Turn screw clockwise to cause belt to move toward the observer. Turn screw counterclockwise, to move belt away from the observer.

c. When the belt rides centered on the pulley, hold the screw in position and retighten the locknut.

14. Remove power and reinstall back panel and fan assembly removed in step 1.

3-146. *Capstan Motor Bearing Replacement.* To replace the two capstan motor bearings, remove capstan motor assembly from the transport:

1. Remove the capstan motor assembly from the transport by performing the *Capstan Motor Assembly Replacement* procedure steps 1 through 5, paragraph 3-144.

CAUTION

HANDLE CAPSTAN MOTOR CAREFULLY PERMITTING NO TACH DISC DAMAGE TO OCCUR. FOR BENCH WORK, CLAMP THE MOTOR MOUNTING PLATE IN THE AREA SHOWN IN FIGURE 3-89 IN A SMALL VISE.

2. Remove two 4-40 X 0.250 cross-head screws securing tach sensor shroud to capstan motor housing; remove shroud (Figure 3-89). The exposed tach disc is fragile and must not be damaged.

3. Remove two 4-40 X 0.250 cross-head screws securing optical switch assembly to capstan motor housing; remove switch assembly.

4. Remove two 8-32 X 0.375 cross-head screws securing motor brush plate to capstan motor housing.

CAUTION

FOR THE NEXT STEP USE CARE TO PULL THE MOTOR BRUSH PLATE STRAIGHT UP FROM THE MOTOR HOUSING WITHOUT SLIDING LATERALLY AS DAMAGE TO THE ROTOR CAN OCCUR. DO NOT SCRATCH OR TOUCH PRINTED MOTOR ROTOR SURFACE – ESPECIALLY IN COMMUTATOR AREA.

5. The permanent magnet within the motor brush plate tends to hold the plate to the motor housing. Use a flat-bladed screwdriver in the slots provided in the front plate of the motor to carefully pry the plate up from the housing and remove the plate.

CAUTION

ALLOW NO METALLIC PARTICLES TO GATHER ON THE PERMANENT MAGNET.

6. Loosen the setscrew in the rotor hub securing the hub to the pulley shaft and remove the rotor assembly.

7. Remove retaining "E" ring securing lower bearing. Remove 0.375 shim washer from pulley shaft.

8. Grasp pulley cap and carefully pull pulley shaft from the top of the motor housing.

9. Remove the upper bearing. Discard bearing. Do not remove the capstan motor spring.

10. Install new prelubricated bearings (Ampex Part No. 420-063):

    a. Insert new lower bearing into housing assembly.

    b. Verify that the following parts are on the pulley shaft in the following order: capstan spring, 0.875 plain washer, and 0.375 shim washer.

    c. Insert new upper bearing into housing assembly.

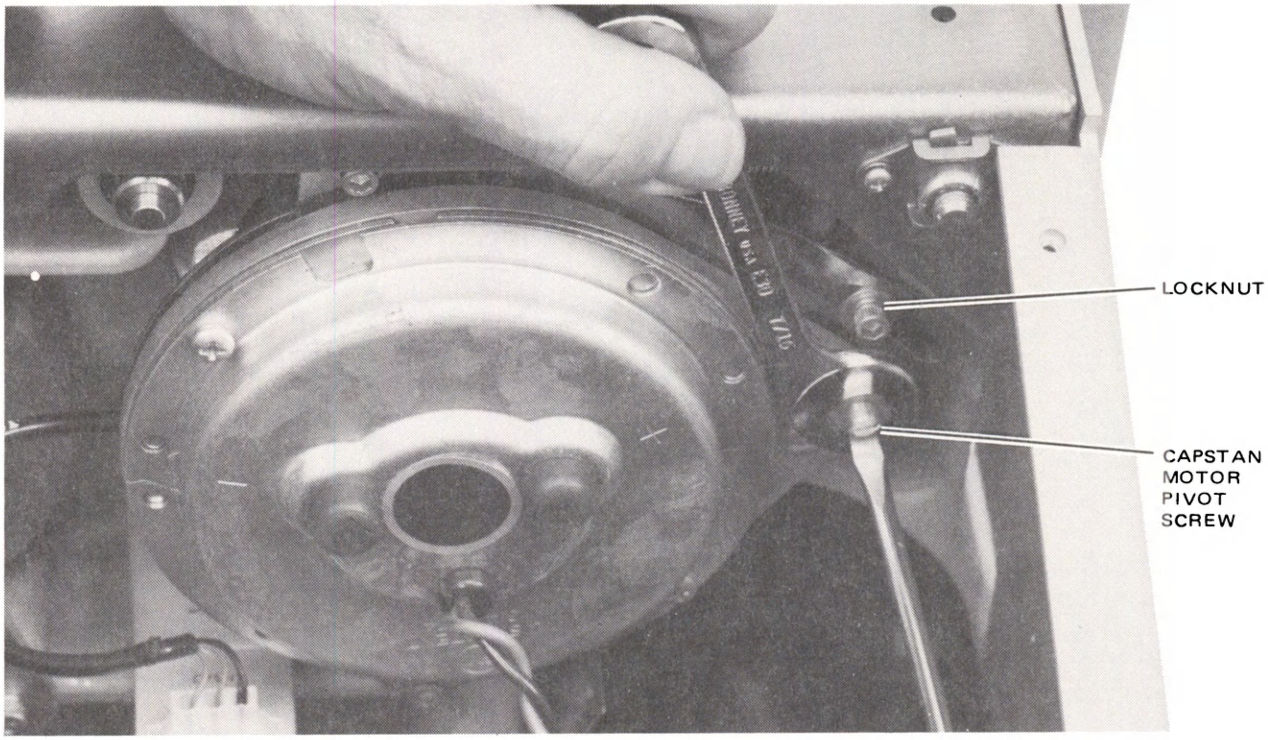


Figure 3-88. Adjusting Capstan Motor Pivot Screw

d. Applying no force to the tach disc, reinstall pulley shaft into housing assembly.

e. Reinstall 0.375 shim washer and retaining "E" ring removed in step 7.

f. Reinstall rotor hub onto pulley shaft and set gap, between front plate and rear side of rotor, to 0.015/0.020 in. (0.38/0.508 mm). Tighten setscrews (2) in rotor hub.

g. Reinstall motor brush plate rear cover and secure with screws removed in step 4.

11. Reinstall optical switch assembly to the capstan motor housing using screws removed in step 3.

12. Reinstall tach sensor shroud to the capstan motor housing using screws removed in step 2.

13. Reinstall and adjust capstan assembly by performing *Capstan Motor Assembly Replacement* procedure, steps 6 through 14 (paragraph 3-144).

3-147. *Capstan Motor Brushes Replacement.* The capstan motor brushes are attached to the inside of the motor brush plate (rear cover). The brushes may be changed without removing the entire motor. Proceed as follows:

1. Remove the capstan motor assembly from the transport by performing the *Capstan Motor Assembly Replacement* procedure, steps 1 through 5, paragraph 3-144.

2. Remove two 8-32 X 0.375 cross-head screws securing motor brush plate to capstan motor housing.

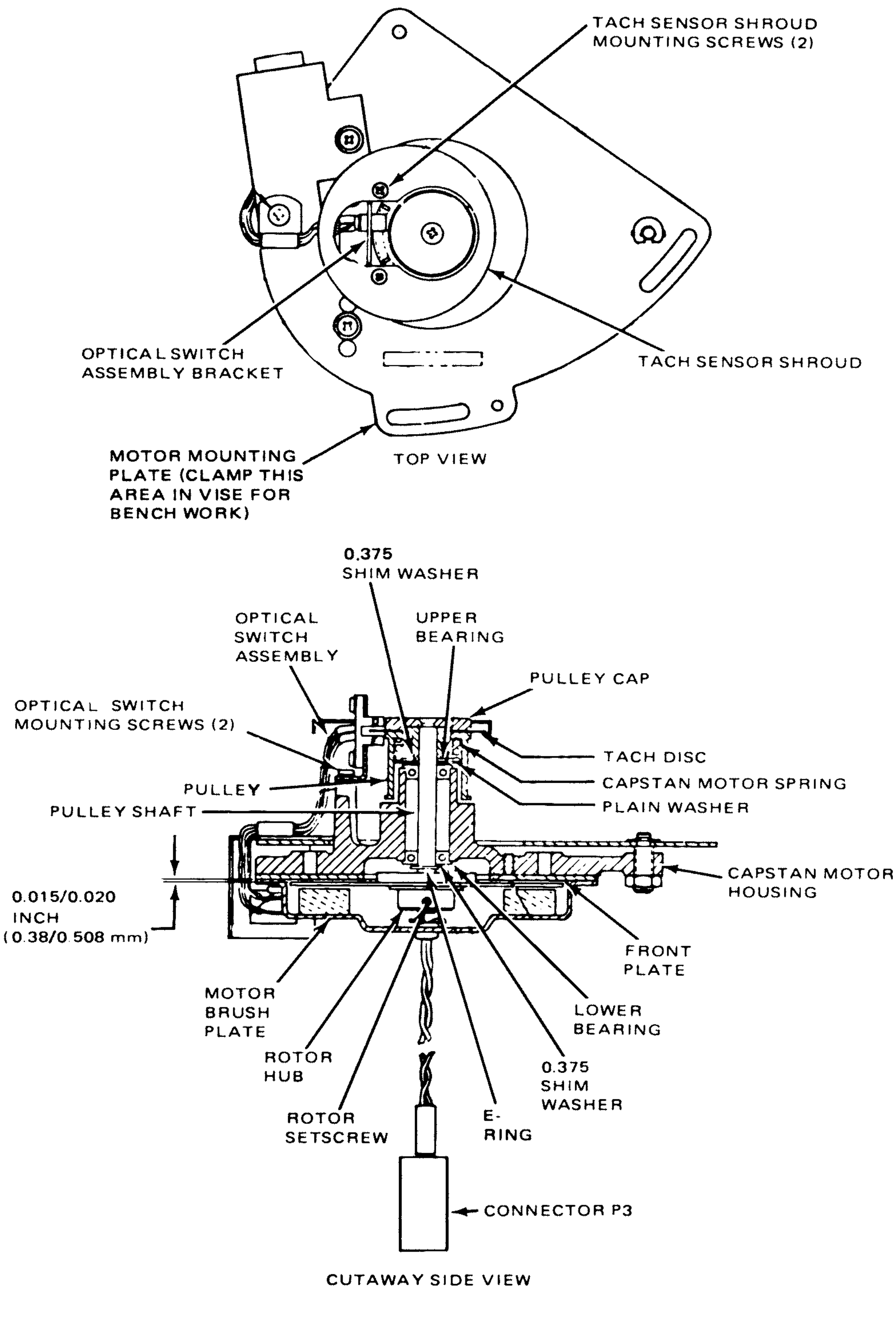


Figure 3-89. Capstan Motor Assembly

CAUTION

FOR THE NEXT STEP USE CARE TO PULL THE MOTOR BRUSH PLATE STRAIGHT UP FROM THE MOTOR HOUSING WITHOUT SLIDING LATERALLY AS DAMAGE TO THE ROTOR CAN OCCUR. DO NOT SCRATCH OR TOUCH PRINTED MOTOR ROTOR SURFACE ESPECIALLY IN COMMUTATOR AREA.

3. The permanent magnet within the motor brush plate tends to hold the plate to the motor housing. Use a flat-bladed screwdriver in the slots provided in the front plate of the motor so carefully pry the plate up from the housing and remove the plate.

CAUTION

ALLOW NO METALLIC PARTICLES TO GATHER ON THE PERMANENT MAGNET.

4. Unsolder each brush lead and remove brushes, taking care to save brush springs.

5. Install brushes (Ampex Part No. 7356040) and springs. Before soldering brush leads, adjust lead lengths so that spring does not force brush from brush holder. While soldering lead, clamp brush lead with long-nose pliers to prevent solder from wicking into braid.

CAUTION

USE SILICON-OXIDE SANDPAPER ONLY (400 GRIT) TO CONTOUR BRUSH ENDS.

6. Contour brush ends by placing the rear cover face down on a sheet of 400-grit silicon-oxide sandpaper placed on a hard flat surface. Rotate the rear cover counterclockwise approximately 90° about five times. Clean all contamination from the magnet and then clean brushes with isopropyl alcohol. Remove all residue.

7. Reinstall rear cover onto motor housing using screws removed in step 2.

8. Reconnect capstan motor power connector P3 removed in step 1.

3-148. *Capstan Motor Optical Switch Assembly Replacement.* Proceed as follows:

1. Remove the capstan motor assembly from the transport by performing the *Capstan Motor Assembly Replacement* procedure, steps 1 through 5 (paragraph 3-144).

CAUTION

HANDLE CAPSTAN MOTOR CAREFULLY, PERMITTING NO TACH DISC DAMAGE TO OCCUR. FOR BENCH WORK, CLAMP THE MOTOR MOUNTING PLATE IN THE AREA INDICATED IN FIGURE 3-89 USING A SMALL VISE.

2. Remove two 4-40 X 0.250 cross-head screws securing tach shroud to capstan motor housing; remove shroud (Figure 3-89). The exposed tach disc is fragile and must not be damaged.

3. Remove two 4-40 X 0.250 cross-head screws securing optical switch assembly to capstan motor housing; remove switch assembly.

4. Using care not to damage tach disc, install new optical switch assembly (Ampex Part No. 1379053) using screws removed in step 3.

5. Reinstall tach shroud using screws removed in step 2.

6. Reinstall and adjust (if necessary) the capstan motor assembly by performing *Capstan Motor Assembly Replacement* procedure, steps 6 through 14 (paragraph 3-144).

3-149. Reel Drive Motors and Brush Replacement. The supply and takeup ac motors are supplied by several vendors and may be used interchangeably in a supply or takeup motor position. However brushes for motors of different vendors are not interchangeable. The correct brush for a given vendor motor must be used.

3-150. *Reel Drive Motor Replacement.* Supply and takeup motor assemblies are removed and installed from the transport front. These assemblies are nearly identical and they both incorporate a reel tachometer PWA. Remove and reinstall a supply or takeup motor:

1. Remove transport trim to gain access to reel motors (refer to *Trim Removal Procedure,* paragraph 3-8).

2. Place a rubber band on the appropriate supply or takeup motor parking brake solenoid (around solenoid and pivot shaft — Figure 3-7) to simulate an energized position.

3. Remove fan assembly from top of portable case (if applicable) by removing six cross-head screws. Disconnect fan connector P1.

4. Disconnect appropriate supply motor connector P2 or takeup motor connector P1 from MDA power panel (Figure 3-90).

5. Disconnect appropriate takeup or supply motor tachometer connector.

CAUTION

THERE ARE TWO LOOSE PILOT BUSHINGS THAT LOCATE EACH MOTOR ASSEMBLY WITHIN THE BASE CASTING WELL. ALSO, BOTH MOTORS HAVE FOUR SPACERS LOCATED BETWEEN THE MOTOR MOUNTING PLATE ASSEMBLY AND THE BASE CASTING. DO NOT ALLOW BUSHINGS OR SPACERS TO FALL INTO ELECTRONICS SECTION OF TRANSPORT.

6. Remove four cross-head screws (Figure 3-91) securing motor mounting plate to base casting. Note that for both motors there are four spacers located between the motor mounting plate and the base casting (in addition to the two pilot bushings). When reinstalling the motor, be sure to reinstall the four spacers.

7. Remove supply or takeup motor assembly from front of transport.

8. Remove circular trim plate (retainer) from top of reel knob by removing one socket-head screw (Figure 3-91).

9. Loosen two 10-32 hex socket setscrews securing reel turntable to motor shaft. These setscrews are accessed through a slot in the motor mounting plate. (Rotate the turntable to gain access to the screws, which are located 90° apart.)

10. Use a 3/32 hex wrench to turn 10-32 setscrew clockwise (located within the center of the turntable shaft) to force the turntable upward on the motor shaft. This allows the turntable to be removed from the motor shaft. (Note: Do not lose the 0.438-inch diameter disc installed on top of the motor shaft.)

11. Remove motor mount plate from motor by removing four pan-head screws.

12. Install motor mount plate onto new motor. Note orientation of motor power connector, motor brush housing, the reversible motor mount plate, and Reel Tachometer PWAs as shown in Figure 3-92 and 3-93. Secure motor mount plate to motor with four screws removed in step 6. Note that the longer screws (10-32 X 0.875) are used to mount the Tachometer PWA.

13. Before tightening screws that secure the Reel Tachometer PWA, position Reel Tachometer PWA exactly 0.438 inch away from outside diameter of motor shaft as follows: Use the 0.438-inch-diameter disc (removed in step 10) as a gauge placed between the edge of the PWA board and the shaft of the motor.

14. Two different setscrews (loosened in step 9) secure the reel turntable to the motor shaft. One screw has a cup point and the other has a cone point. The cone point setscrew is seated and tightened into the "V" groove of the motor shaft prior to tightening the cup point screw. Reinstall the 0.438-inch-diameter disc and the turntable onto the motor shaft.

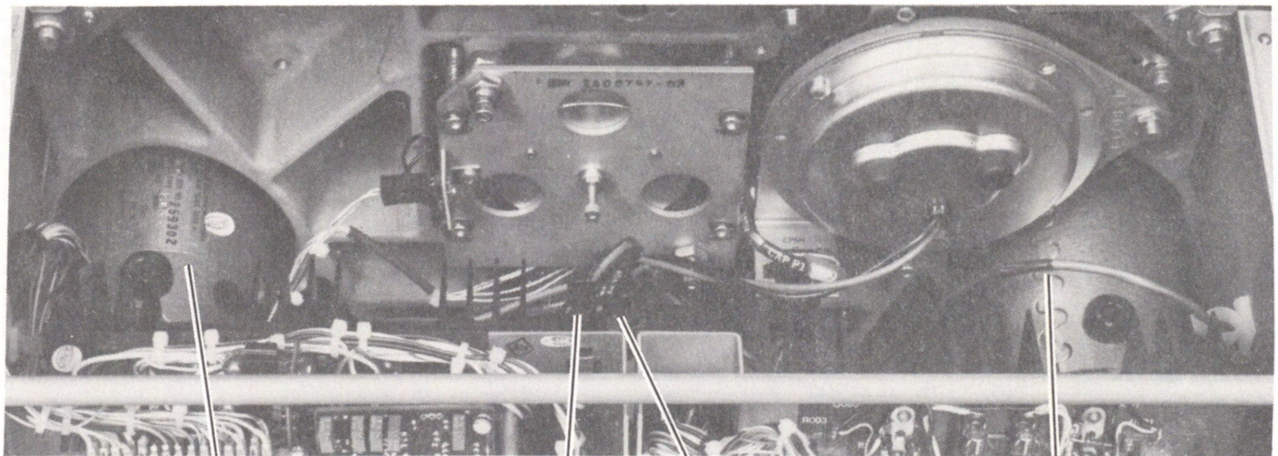


Figure 3-90. Supply and Takeup Motor Assemblies, Rear View of Transport

15. Set turntable height. Since the cork pad on the turntable is soft, it does not serve as a suitable reference for measuring turntable height. For this reason, a metal flange from a reel of tape is removed from the reel, placed on the turntable, and used as a reference for the turntable height measurement. Proceed as follows:

    a. Remove the metal flange from a tape reel.

    b. Using a caliper (or similar tool), measure the thickness of the flange removed. Record this thickness.

    c. Place the flange onto the turntable.

    d. Using a caliper, measure the distance between the surface of the motor mount plate and the surface of the tape reel flange. Figures 3-92 and 3-93 may be referred to although the tape reel flange is not indicated in these drawings. Record this reading.

    e. Subtract the thickness of the reel flange from the value recorded in step 15d above. The resulting distance should be 1.094 inch (27.79 mm) as shown in Figures 3-92 and 3-93. To adjust turntable height, proceed below.

    f. To adjust turntable height, turn the setscrew located within the center of the turntable shaft. After final adjustment, the end of the setscrew must be firm against the 0.438-inch reel motor disc. If it is not, the turntable height setting may change when tape reels are installed on the turntable.

16. After height is established, tighten the two 10-32 setscrews securing turntable assembly to motor shaft. Remove the tape reel flange.

17. Reinstall circular trim plate removed in step 8.

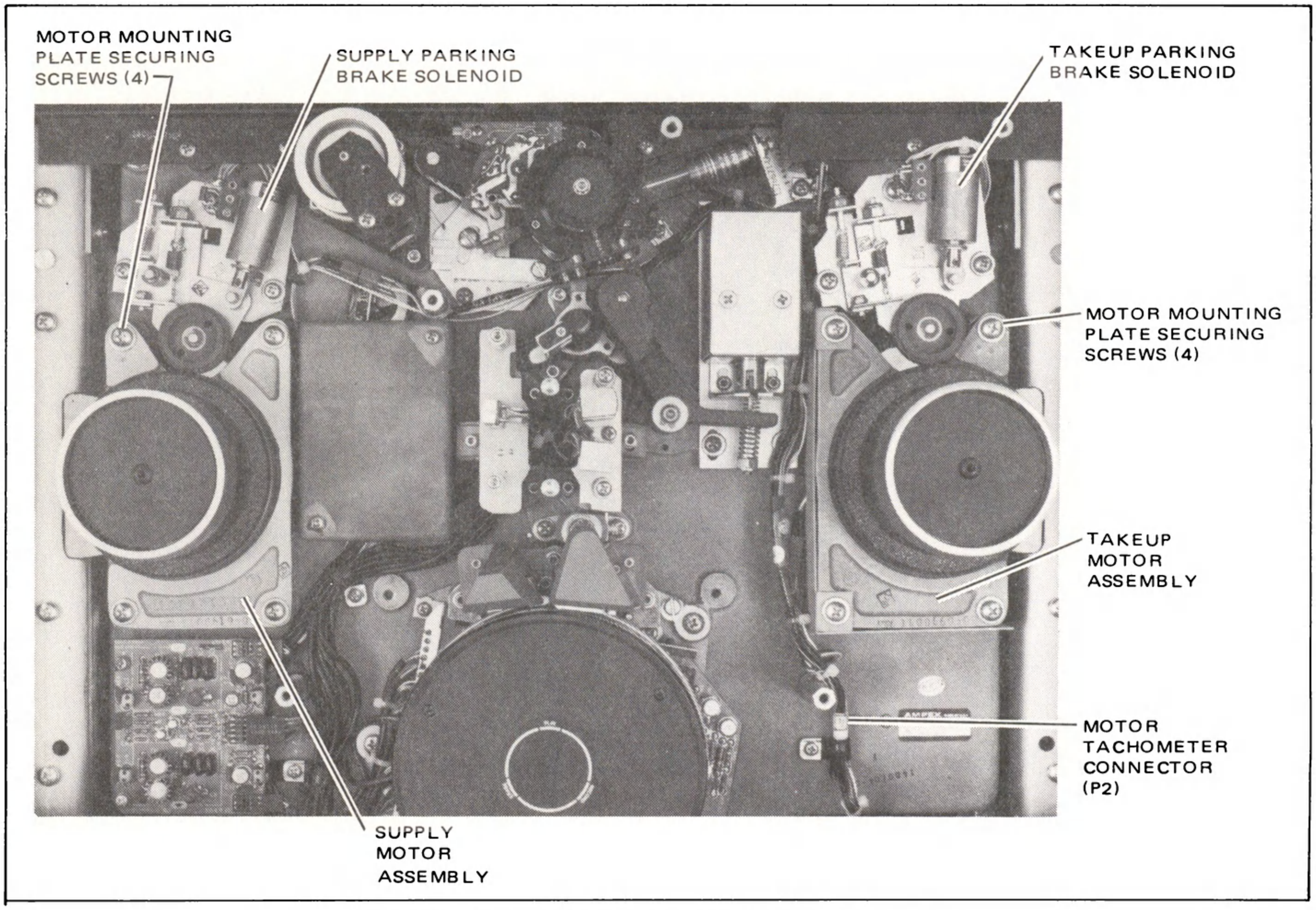


Figure 3-91. Supply and Takeup Motor Assemblies

18. Reinstall motor assembly onto transport using screws removed in step 6.

19. Reconnect reel tachometer connector disconnected in step 5.

20. Reconnect motor connector P2 (supply) or P1 (takeup) disconnected in step 4.

21. Reinstall fan assembly and connector P1 (if applicable) removed in step 3.

22. Remove rubber band installed in step 2.

23. Reinstall transport trim removed in step 1.

3-151. *Brush Replacement.* The two motor brushes seldom wear out; however, a brush may chip or become noisy and therefore need replacing. Proceed as follows:

1. Remove the appropriate supply or takeup motor assembly by following steps 1 through 7 of the *Reel Drive Motor Replacement* procedure, paragraph 3-149.

2. To remove a brush, use a large-bladed screwdriver and unscrew the motor endplug. The brush has a spring attached which maintains pressure against the motor commutator. Slide the old brush out of the retaining hold in the motor.

3. Clean the new brush with isopropyl alcohol and allow to dry. Install new brush in the motor.

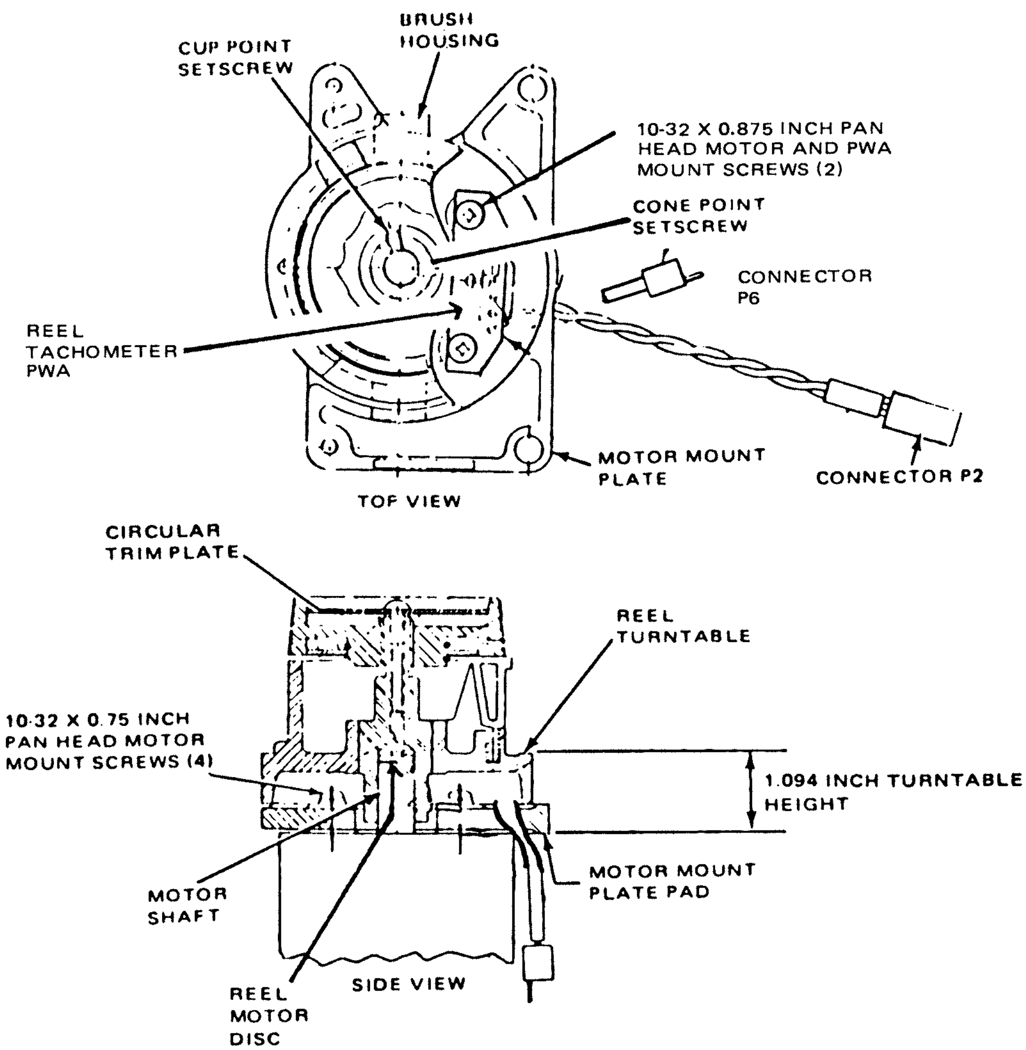


Figure 3-92. Supply Reel Motor Drive Assembly

4. Secure new brush and spring with endplug removed in step 2.

5. Reinstall reel drive motor assembly in the reverse order of disassembly.

CAUTION

A NEW BRUSH MAY SQUEAK UNTIL THE MOTOR HAS BEEN RUN LONG ENOUGH TO SEAT THE NEW BRUSH TO THE COMMUTATOR. DO NOT APPLY ANY LUBRICANTS TO THE BRUSH.

3-152. Capstan Shaft and Stanchion Replacement. The stanchion (Figure 3-94) contains permanently lubricated bearings and is used to support the capstan shaft.

3-153. *Capstan Shaft Replacement.* To replace the capstan shaft, proceed as follows:

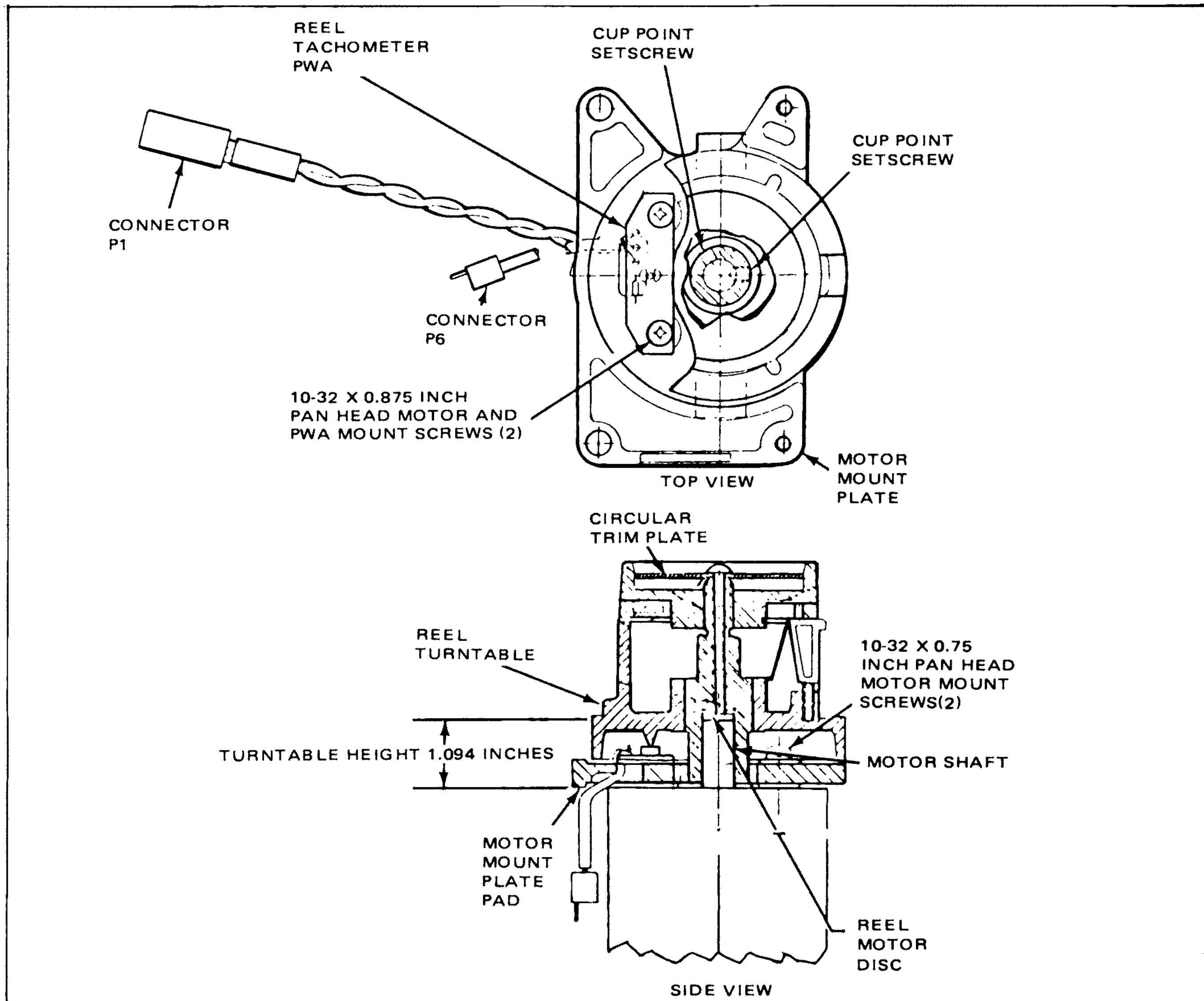


Figure 3-93. Takeup Reel Motor Drive Assembly

1. Remove the capstan brake assembly using the Capstan Brake Assembly Replacement Procedure, paragraph 3-141, steps 1 through 5.

2. Loosen the No. 6 cap-head screw securing the thrust wand assembly to the stanchion (Figure 3-94) and remove the thrust wand assembly.

3. From underside of transport, loosen capstan motor mounting screws (Figure 3-88) and pivot motor to the left to release tension on the belt; remove belt from capstan flywheel.

4. Pull capstan flywheel away from transport just far enough to allow access to flywheel mounting setscrews but not so far that the capstan shaft coating contacts the top of the stanchion. Loosen setscrews and remove flywheel. Remove capstan shaft from top of transport.

5. Prepare to install new capstan shaft:

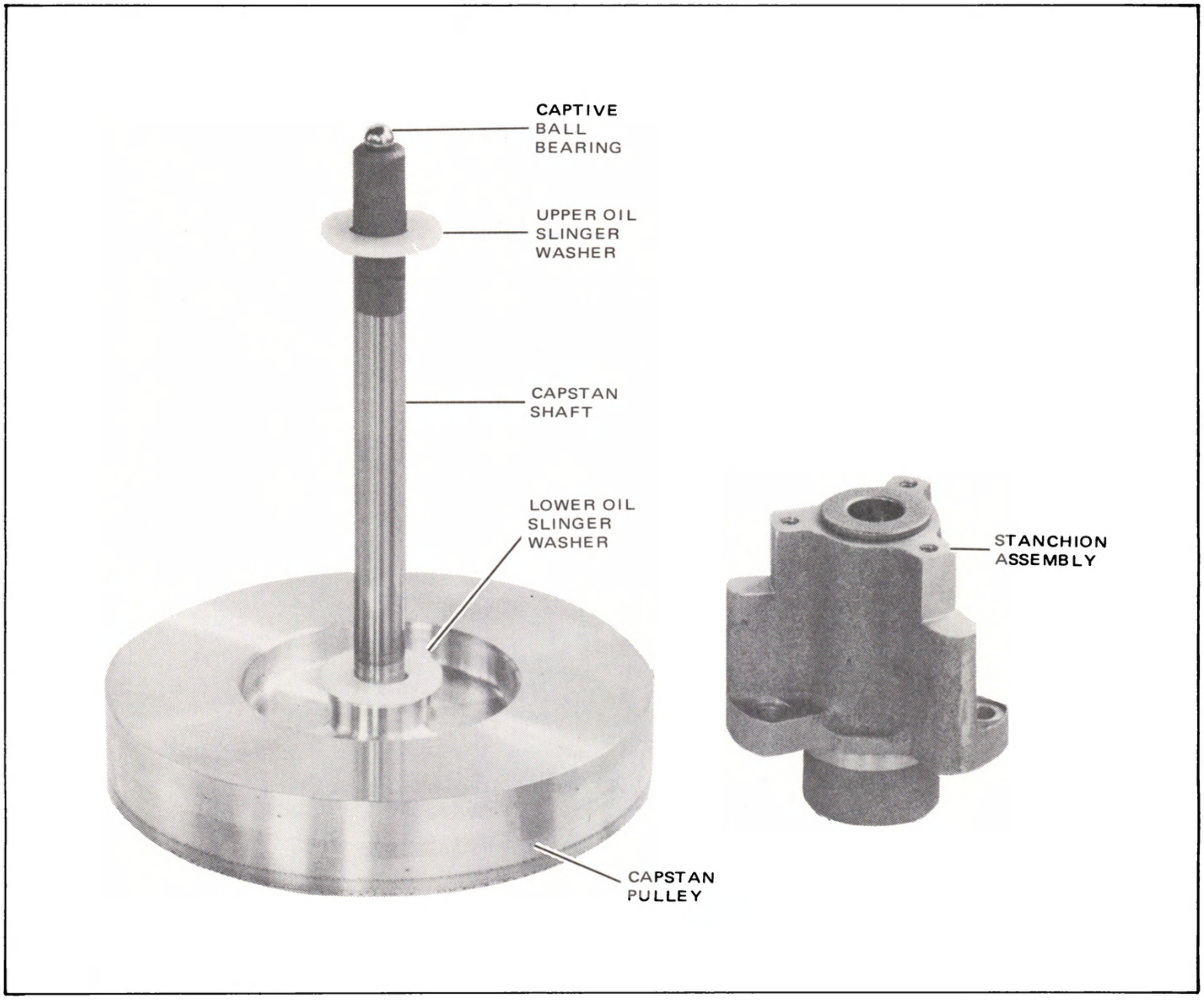


Figure 3-94. Capstan Shaft and Related Components

a. Clean shaft using isopropyl alcohol.

b. Preassemble cable clamp (Ampex Part No. 302-200) with 8-32 X 0.375 inch screw, two No. 8 flatwashers, and a No. 8 hexnut. Slip assembled cable clamp over bottom of capstan shaft and position just below coating on shaft.

c. Slip one oil slinger washer over bottom of capstan shaft and up against cable clamp.

6. Insert capstan shaft (with cable clamp and oil slinger washer in place) through stanchion from top (Figure 3-85).

7. Slip second oil slinger washer over capstan shaft from bottom.

8. Position top of capstan ball 1.83 inch from the top of the capstan stanchion (not from top of bearing). Use the capstan top gauge bracket (Ampex Part No. 1400542), installed with a 0.030 inch (0.79 mm) washer (Ampex

Part No. 501-008) under its mounting foot (Figure 3-85). Secure with No. 4-40 X 0.312 inch screw. Hold capstan up against bracket and slide cable clamp down against bearing. Tighten screw in cable and clamp; the clamp should be positioned to keep the capstan from sliding (away from bracket) but still allow rotation.

9. Slip capstan pulley (flywheel) onto capstan with hub side out. Secure pulley (two set-screws) to capstan after sliding it toward the transport casting and bottoming out against the lower oil slinger washer.

10. Install capstan drive belt. Set preliminary belt tension by pivoting motor approximately 1/4 inch counterclockwise and release; lightly tighten mounting screws.

11. Manually rotate motor and roughly center belt by adjusting pivot screw (Figure 3-88), loosen locknut as required).

12. Establish elevation of capstan ball at 1.80 inches above top of stanchion.

    a. Remove capstan top gauge bracket, eliminate 0.030 inch spacer, and replace bracket onto stanchion — do not tighten.

    b. Loosen cable clamp screw to allow capstan to slip downward slightly.

    c. Tighten screw to secure top gauge bracket.

    d. Hold capstan up against top gauge bracket; position capstan and tighten cable clamp screw as done in step 8 above.

13. Replace capstan brake assembly and establish the required clearances by performing the Capstan Brake Assembly Replacement procedure Paragraph 3-141, steps 6 through 14.

3-154. *Stanchion Replacement.* To replace the capstan stanchion, proceed as follows:

1. Remove the capstan shaft. Perform the *Capstan Shaft Replacement* procedure, paragraph 3-152, steps 1 through 4.

2. Remove the two Phillips pan-head screws securing the Optical Switch PWA assembly (Figure 3-79). This allows the PWA to move clear of the stanchion during removal.

3. Remove the locking nut holding the pinch roller spring; remove the spring as well. Pivot the pinch roller clockwise to allow clearance for the stanchion.

4. Remove three hex-socket cap screws securing the stanchion to tape transport casting. Remove the stanchion.

5. Examine the new stanchion bottom mating surface. Any nicks or mars on the machined surface may hinder critical flush and square stanchion installation. Carefully remove any such blemish using a small file.

6. Clean the stanchion bottom mating surface, and the transport mating surface with isopropyl alcohol.

7. Install new stanchion (Ampex Part No. 1400700). Secure with three screws removed in step 4.

8. Replace the Optical Switch PWA assembly using two screws removed in step 2.

9. Replace the pinch roller spring and locking nut removed in step 3.

10. Replace capstan shaft. Perform the *Capstan Shaft Replacement* procedure, paragraph 3-152, steps 5 through 12; including *Capstan Brake Assembly Replacement* procedure, paragraph 3-141, steps 6 through 14 (do not replace top trim panels yet).

11. Restore proper pinch roller pressure. Perform the *Capstan Pinch Roller Pressure Adjustment* procedure, paragraph 3-28, all steps.

12. Install the top trim panels of the VPR.

3-155. Dashpot Assembly Replacement and Adjustment. When entering play or record mode from standby mode, the tape is tensioned and the dashpot enables the tension arm to move smoothly

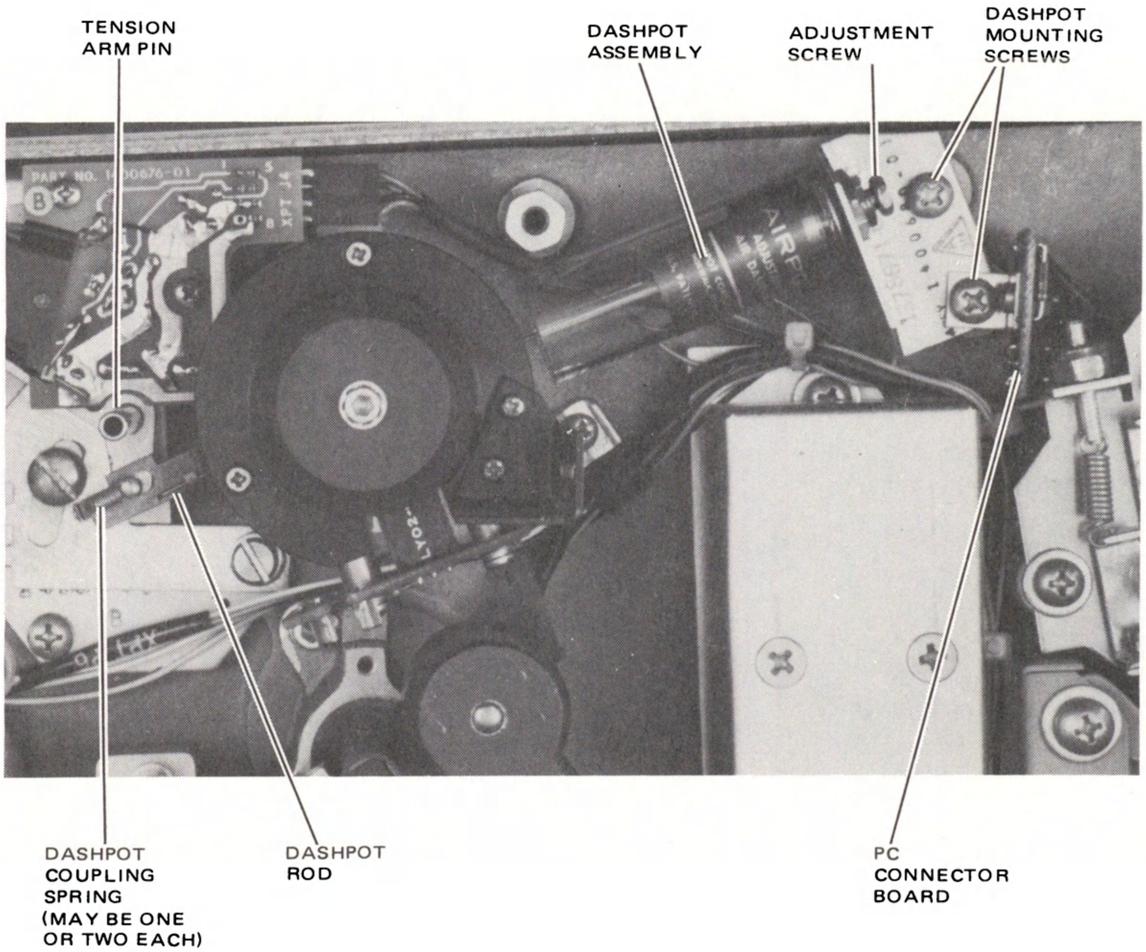


Figure 3-95. Dashpot Assembly

to the center of its operating range without overshoot. The dashpot is a one-way type and offers resistance as the piston is pulled from the cylinder. The air resistance is increased when the adjustment screw is turned clockwise and decreased as the screw is turned counterclockwise. To replace and adjust the dashpot assembly proceed as follows:

1. Remove transport trim (paragraph 5-8) to gain access to the dashpot assembly. Remove upper clamshell cover.
2. Carefully unhook the dashpot coupling springs (Figure 3-95) from the dashpot coupling. Do not over-stretch fragile springs.
3. Carefully unhook the two dashpot coupling springs from the tension arm pin.
4. Slide the dashpot coupling off the tension arm pin.
5. Remove two 8-32 cross-head screws securing dashpot bracket (and pc connector board)

to casting. Remove dashpot assembly from transport (push pc board aside).

6. Before installing new dashpot assembly, adjust dashpot air flow as follows: While holding the dashpot cylinder vertically, with the rod dangling downward, turn adjusting screw so that piston requires 2 to 2.5 seconds to fall the length of the cylinder.

7. Reinstall new dashpot assembly (Ampex Part No. 1400680) onto transport in the reverse order of removal. Restore the pc connector board displaced earlier (see Figure 3-95).

8. Check dashpot operation.

   a. Thread tape onto transport.

   b. Set TAPE/EE switch to EE position.

   c. Enter standby ready mode.

   d. While entering play mode, observe tension arm movement. Arm should move to the center of its operating range (over the cam adjustment slot) with minimum overshoot. If there is excessive overshoot, turn dashpot adjustment screw slightly clockwise to increase air resistance and repeat steps 8c and 8d.

   e. Check normal holdback tension while entering play mode from standby with a Tentelometer tension gauge placed between scanner entrance guide and fixed guide (Figure 3-8). (Normal tension in play mode is 4.0 to 4.5 ounces.) Enter play mode from standby mode. Tape tension will momentarily exceed 4.0 to 4.5 ounces and then should recover to normal tension in less than 1 second. If time is greater than 1 second, turn dashpot adjustment screw slightly counterclockwise to decrease air resistance and repeat standby to play mode test.

9. Remove tape and reels and reinstall transport trim and clamshell removed in step 1.

3-156. Capstan Pinch Roller Replacement. Replace capstan pinch roller (includes bearings) — part of the pinch roller arm assembly (Figures 3-96 and 3-97).

1. Remove transport trim (paragraph 3-8) to access the pinch roller arm assembly and the capstan solenoid (Figure 3-96).

2. Remove the pinch roller solenoid assembly hexagon locking nut and pinch roller spring.

3. To allow removal of the pinch roller arm assembly, remove three cross-recessed 8-32 screws (Figure 3-96), securing pinch roller solenoid to transport. Do not pull or pinch neighboring wires while moving assembly.

4. Remove retaining ring (Figure 3-96) securing pinch roller arm assembly to pinch roller pivot shaft. Remove upper pinch roller washer and pinch roller arm assembly from shaft. Leave lower pinch roller washer on shaft.

5. Install new pinch roller (Ampex Part No. 1378726) and new shaft (Ampex Part No. 421-378) onto pinch roller arm:

   a. Loosen two pinch roller arm setscrews (Figure 3-97).

   b. Remove shaft and pinch roller assembly. Retain the two delrin washers.

CAUTION

USE MINIMAL OIL TO LUBRICATE BEARINGS. ANY EXCESSIVE OIL WILL CONTAMINATE THE PINCH ROLLER AND (THEREBY) THE TAPE.

   c. Permit no oil to contact new pinch roller. Prime each bearing (two each) with one small drop of turbine oil (see Table 3-1). Wipe bearings to remove any excessive oil.

   d. Wipe delrin washers with a clean, dry rag. Install new pinch roller assembly and shaft, and the two retained delrin washers onto pinch roller arm (Figure 3-97). Tighten setscrews.

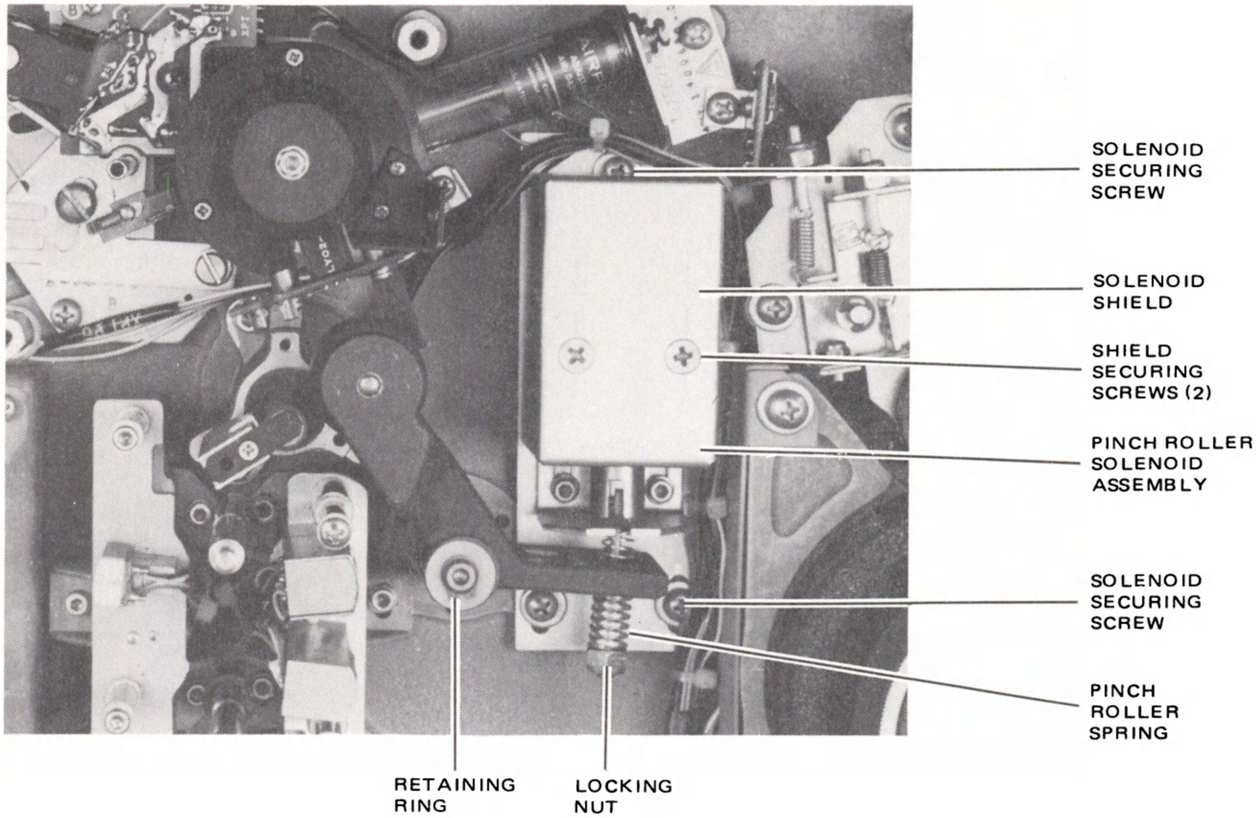


Figure 3-96. Pinch Roller Solenoid Replacement

6. Reinstall pinch roller arm assembly and pinch roller washer (removed in step 4) onto pinch roller pivot shaft while inserting solenoid plunger screw through pinch roller arm.

7. Reinstall retaining ring removed in step 4.

8. Reinstall pinch roller solenoid using three 8-32 screws removed in step 3. Use care; do not pinch wires under solenoid assembly.

9. Reinstall pinch roller spring and hexagon locking nut removed in step 2.

10. Set capstan pinch roller pressure and clearances as described under *Capstan Pinch Roller Pressure Adjustment* (paragraph 3-28).

11. Reinstall trim panels removed in step 1.

3-157. Pinch Roller Solenoid Replacement. Replace the pinch roller solenoid assembly (Ampex Part No. 1378860) as follows:

1. Remove transport trim (paragraph 3-8) to access pinch roller solenoid assembly (Figure 3-96).

2. Remove two flat-head cross recessed screws securing solenoid shield to solenoid housing. Remove shield.

3. Remove solenoid assembly hexagon locking nut and pinch roller spring (Figure 3-96) from solenoid plunger screw.

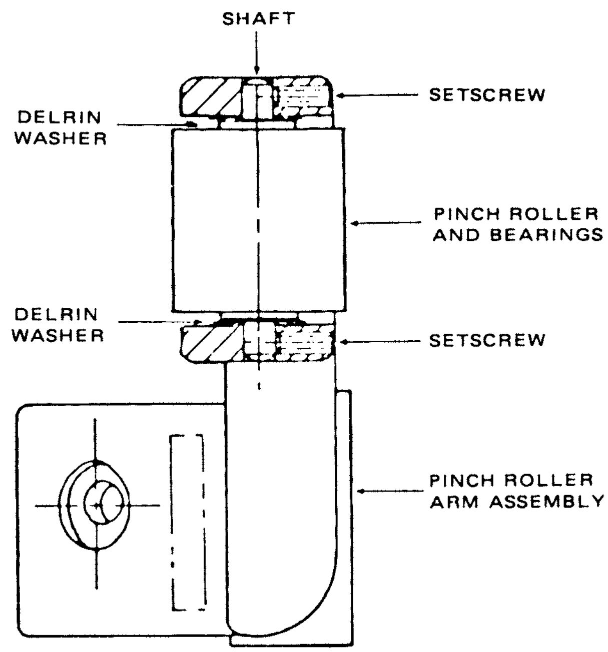


Figure 3-97. Capstan Pinch Roller Replacement

4. Put identifying labels on solenoid leads and unsolder leads from parking brake junction pc board. Permit no solder to fall into the machine.

5. Remove three cross-recessed 8-32 screws securing pinch roller solenoid to transport. Remove solenoid. Do not pull or pinch neighboring wires.

6. Install new solenoid in reverse order of disassembly. Do not pinch wires under solenoid assembly.

7. Set capstan pinch roller pressure and clearances as described under *Capstan Pinch Roller Pressure Adjustment* (paragraph 3-28).

8. Reinstall trim panels removed in step 1.

3-158. Parking Brake Parts Replacement. The supply and takeup parking brake assemblies are identical. Parts that may require replacement are: brake hub tire, brake hub, brake band assembly, and brake solenoid. During a replacement procedure clean the brake hub tire, brake hub, brake band assembly, and turntable hub with isopropyl alcohol.

CAUTION

USE NO FORM OF LUBRICANT ON THE BRAKE BAND OR HUB. THE BRAKE HUB IS MADE OF TEFLON-FILLED DELRIN AND REQUIRES NO SUPPLEMENTAL LUBRICATION.

Perform the following steps as applicable.

1. Change the brake hub tire (Ampex Part No. 1378868).

   a. Pull old brake hub tire off brake hub.

b. Install new hub tire into groove on hub with molded side (shiny side) facing out. No bonding material is required.

2. Remove parking brake assembly from transport (not required for tire replacement).

a. Remove transport trim (paragraph 3-8) to access parking brake assembly (Figure 3-98).

b. Tag and unsolder the two wires from the solenoid.

c. For the supply and takeup parking brake assembly, remove three cross-recrssed screws securing parking brake assembly to transport. Both parking brake assemblies have three loose spacers located under the parking brake base. Do not allow spacers to fall into transport when takeup parking brake is removed. Remove takeup parking brake assembly by removing three cross-recessed screws and three spacers.

3. Change the teflon-filled delrin hub (Ampex Part No. 1378869):

a. Rotate torque adjustment nut (Figure 3-98) counterclockwise until brake band is slack.

b. Remove brass shield as follows: Remove brake band and shield mounting screw (Figure 3-99). Slide shield out of groove in hub.

c. Remove tire and hub from parking brake assembly by removing a single "E" ring and washer.

d. If a new tire is to be installed on the hub, install tire into groove on hub with molded side (shiny side) facing out. No bonding material is required.

e. Install hub and tire onto parking brake assembly. Secure with "E" ring and washer removed in step 3c.

f. Reinstall shield and shield mounting screw removed in step 3b.

4. Change the brake band assembly (Ampex Part No. 1378885):

a. Remove basss shield as follows: Remove brake band and shield mounting screw (Figure 3-98). Slide shield out of groove in hub.

b. Unhook brake band from extension spring and remove brake band.

c. Reinstall brake band and shield in the reverse order of removal. Secure with screw removed in step 4a.

5. Change the brake solenoid (Ampex Part No. 1400633).

CAUTION

THE SOLENOID PLUNGER (OF THE PARKING BRAKE) MUST BE PARALLEL AND IN LINE WITH THE LINKAGE OR PREMATURE WEAR AND IMPROPER OPERATION MAY RESULT. WHEN REPLACING OR OTHERWISE ALTERING SOLENOID POSITION, BE SURE THAT THE SOLENOID PLUNGER IS SO ALIGNED, AND NOT COCKED WITH RESPECT TO LINKAGE.

a. Remove two 4-40 pan-head screws securing brake solenoid to brake assembly base (Figure 3-98). Remove solenoid.

b. Install existing solenoid link onto new solenoid plunger as follows: Note that the spring pin hole in the plunger is enlarged on one side of the plunger slot so that the spring pin may be removed without deforming the slot. Remove the solenoid link from the plunger by pressing the 0.093-inch spring pin out through the enlarged pin hole of the plunger.

c. Secure solenoid link to new solenoid plunger with pin removed in step 5b. Press pin through enlarged pin hole into small pin hole of plunger.

d. Install plunger into solenoid and attach brake solenoid to brake assembly base using screws removed in step 5a. Note that the solenoid plunger-to-linkage alignment must be preserved for proper operation and minimal wear.

6. Reinstall parking brake assembly onto transport using three screws removed in step 2c (and spacers if a takeup parking brake assembly is being installed).

7. Resolder two leads to appropriate solenoid terminals.

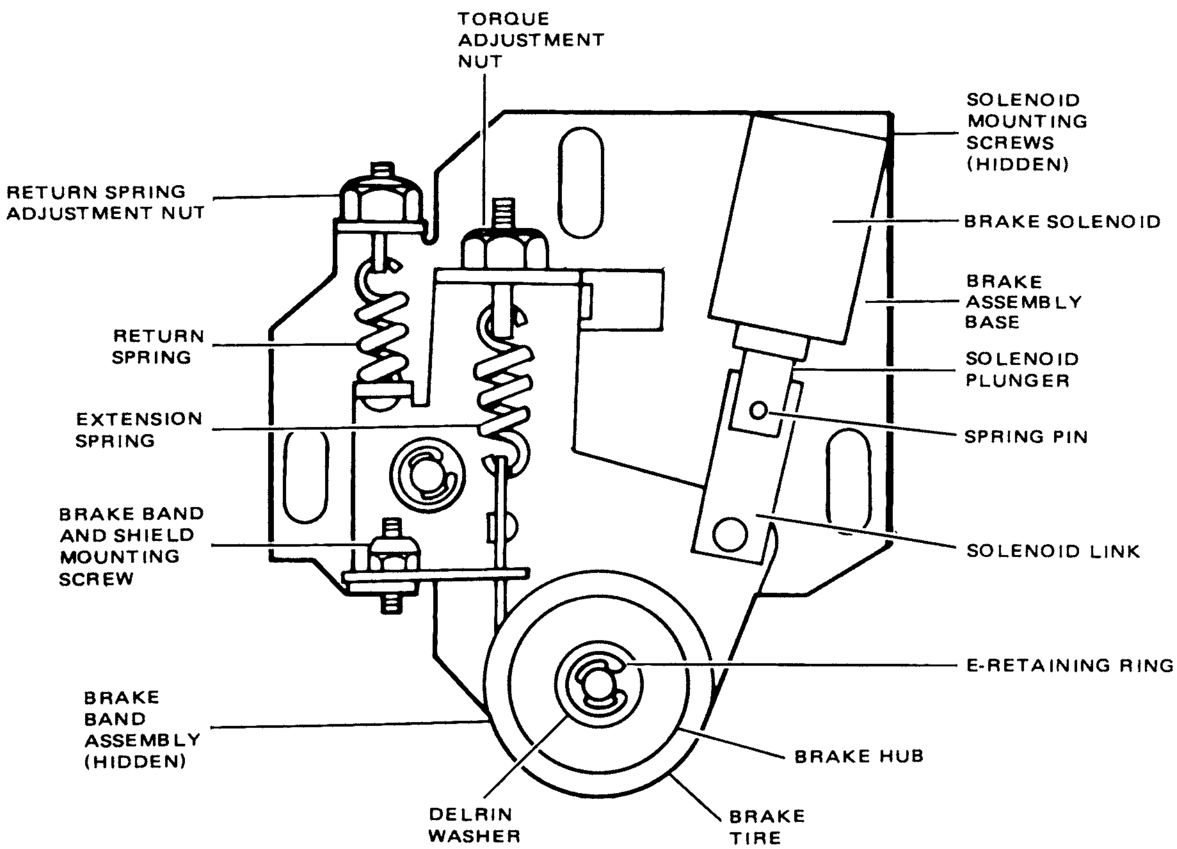


Figure 3-98. Parking Brake Assembly

8. Set tire-to-turntable gap:

   a. Slightly loosen three mounting screws securing parking brake assembly to transport. Manually push solenoid plunger (not the solenoid link pin) into coil. Verify full plunger throw is realized (plunger bottoms out). Hold plunger in and adjust position of the parking brake assembly so there is 0.010 to 0.020 inch (0.25 to 0.51 mm) clearence between rubber tire and turntable. Tighten three mounting screws.

   b. Recheck gap clearance to verify correct adjustment.

9. Adjust brake torque:

   a. Verify that brake engagement spring (which rotates tire assembly into engagement with the turntable) has its upper end hooked into the lowest hole (hole providing weakest spring force) only. Move spring end to lowest force hole (in the tab) if necessary.

   b. Place empty reel on turntable.

   d. Wrap a cord or twind on the reel hub counterclockwise with a loop at the cord-free end. Attach spring scale (48-ounce minimum range) to loop and pull scale slowly and steadily to rotate reel counterclockwise. Force indication on spring scale should be 11 to 13 ounces.

d. Compute torque by multiplying hub radius by force measured in step 9x. Turn torque adjustment nut (Figure 3-98) clockwise (increase torque) or counterclockwise (decrease torque) to obtain between 25- and 30-inch ounces.

e. Apply VPR power. Defeat the end-of-tape sensor with a Q-tip. Place machine in READY mode and verify that, as the reel turns, the tire does not rub at all. If it does, reset tire-to-hub clearance.

10. Reinstall transport trim removed in step 2a.

3-159. Scanner Assembly Removal and Replacement. Follow this procedure to remove and replace the entire scanner assembly, shown in Figures 3-99 and 3-100. Proceed as follows:

NOTE

If the scanner assembly is replaced with another scanner assembly, the following mechanical and electrical procedures must be performed; *Scanner Tach Alignment*, **paragraph 3-34;** *Helical Scan Test and Alignment*, **paragraphs 3-38 through 3-40;** *Helical Scan Dropout,* **paragraphs 3-41 through 3-43;** *Control Track Head Phase*, **paragraph 3-45, and** *Video Optimization* **procedure, paragraph 3-70.**

1. Remove transport trim and scanner shroud assembly (paragraph 3-8).

2. While using care not to pull on connector wires, remove connectors P1 and P3, which connect to the Edit Erase PWA (Figure 3-100.)

3. Remove two screws securing Record Amplifier PWA connector bracket to scanner base casting.

4. Unplug Record Amplifier PWA connector and dress record amplifier connector bracket away from scanner.

5. Remove three cross-head screws and washers securing scanner base casting to transport casting.

CAUTION

WHEN HANDLING SCANNER ASSEMBLY, DO NOT TOUCH PROTRUDING HEAD TIPS. WHEN SCANNER ASSEMBLY IS REMOVED FROM TRANSPORT, IT CAN BE SAFELY SET ON ITS BOTTOM SURFACE (MOTOR COVER).

6. Carefully lift the scanner out of well in transport casting just far enough to permit the scanner's rear connectors to be reached (Figure 3-101).

7. Disconnect the two connectors at rear of scanner to completely free scanner assembly from transport.

8. Remove the Record Amplifier PWA from the slides within the scanner and transfer the PWA to the new scanner assembly.

9. On scanner assembly, remove each screw securing old entrance-guide cover, exit-guide cover, and transfer covers. The heads may be transferred to the new scanner at this time. Refer to the *Scanner Head Replacement* procedure, paragraph 3-132.

10. Reinstall scanner assembly in the reverse order of removal. When installing scanner onto base casting, ensure that scanner mounts flush to casting with no interfering components, wires, etc., between mating surfaces.

CAUTION

DYNAMIC SCANNER BALANCE, AS ACHIEVED AT THE FACTORY, IS CRITICAL. REMOVING AND REPLACING THE PREAMPLIFIER, OR EVEN PARTS THEREOF, DEGRADES THIS BALANCE. SCANNER IMBALANCE MAY CAUSE VIDEO DETERIORATION, OR POSSIBLY DAMAGE THE SCANNER. PERFORM THIS PROCEDURE ONLY IN AN EMERGENCY, AND ONLY WHEN AMPEX SERVICE IS NOT AVAILABLE.

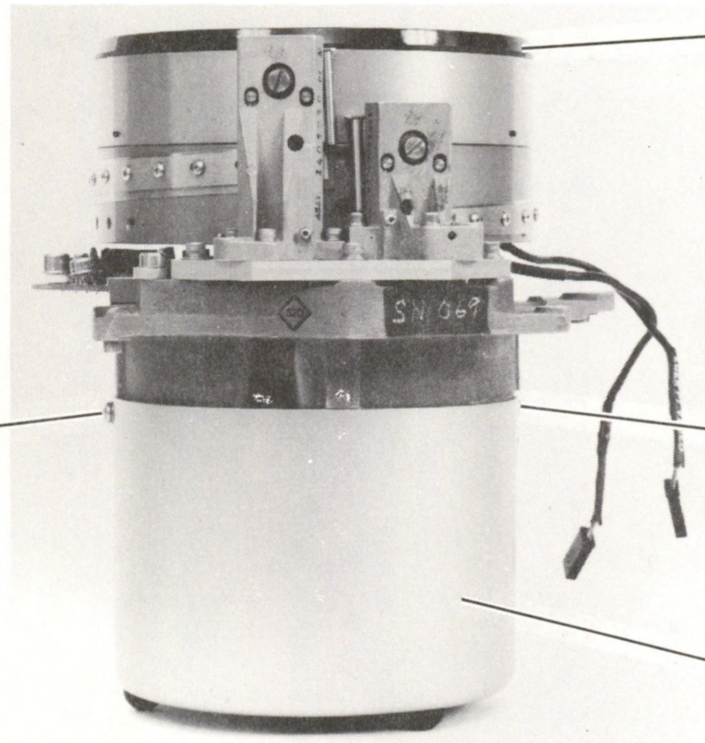


Figure 3-99. Scanner Assembly

3-160. Preamplifier PWA Parts Replacement. If the preamplifier PWA must be replaced (Figure 3-102), then the scanner assembly should be returned to the factory or to a qualified service center so that the rotating scanner drum can be dynamically rebalanced after the Preamplifier PWA is installed. In an emergency however, individual parts on the PWA can be changed in the field without appreciably changing drum balance if certain precautions are taken. These include using replacement parts of the same value, size, and weight and using only an adequate amount of solder. In addition, Preamplifier PWA position on the drum should be scribed before loosening the mounting screws so that the PWA may be reinstalled in the same position as before removal. Proceed as follows:

1. Remove VPR power.

2. Remove three screws securing drum cover to rotating scanner; remove cover.

NOTE

Note position of drum cover with respect to scanner. It must be replaced in exactly this position.

3. Unplug video head connectors P4 through P9.

4. Using a scribe, carefully outline position of Preamplifier PWA on drum.

5. Unsolder leads to PWA terminals. The listing below provides information for identifying leads:

6. Remove three stand-offs securing Preamplifier PWA to drum; remove PWA.

CAUTION

REPLACING PARTS ON THE PREAMPLIFIER CAN SERIOUSLY DEGRADE

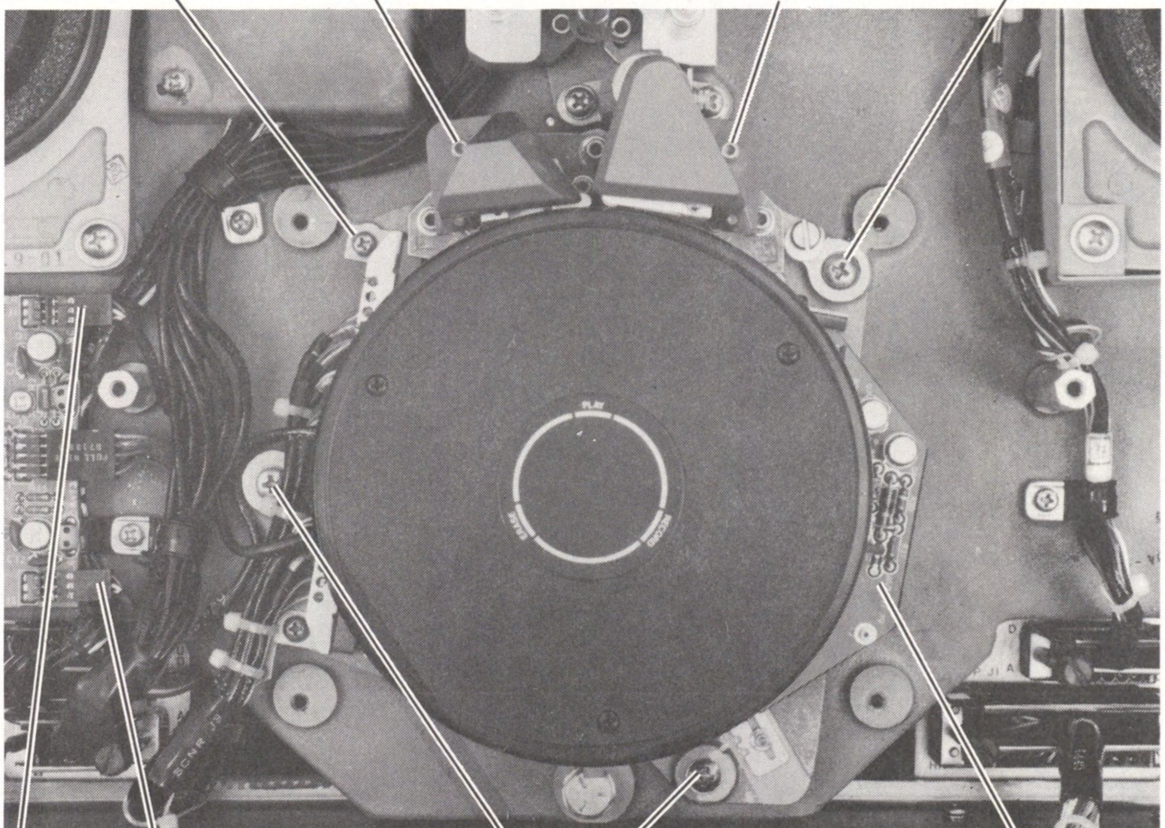


Figure 3-100. Scanner Removal Procedure

SCANNER BALANCE. USE PARTS OF IDENTICAL TYPE, WEIGHT, AND LEAD LENGTH TO THE ORIGINAL. USE A LIKE AMOUNT OF SOLDER, AND POSITION PARTS AS THEY WERE ORIGINALLY POSITIONED.

CAUTION

REPLACE THE PREAMPLIFIER IN EXACTLY THE SAME POSITION IT WAS INSTALLED ORIGINALLY.

7. After parts are replaced on the PWA, reinstall PWA on the scanner drum in the exact location described in step 4. Secure with standoffs removed in step 6.

8. Resolder leads and shield wires disconnected in step 5. Improper lead dress may cause record and AST head crosstalk. Route leads as shown in Figure 3-102. When soldering terminals, use minimal solder so scanner dynamic balance is preserved.

9. Reconnect video head connectors.

10. Reinstall drum cover (three screws).

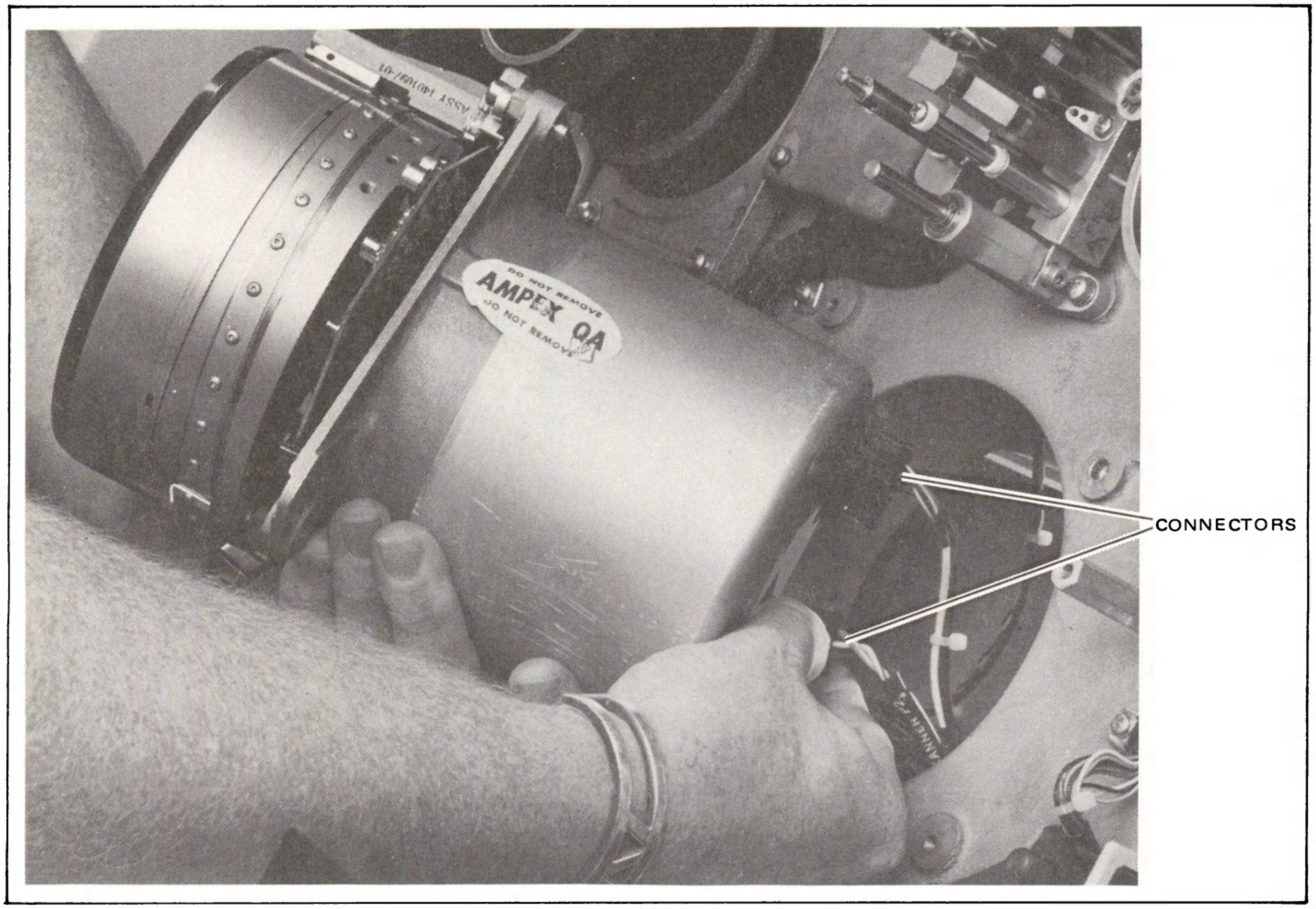


Figure 3-101. Scanner, Two Rear Connectors

PREAMPLIFIER PWA TERMINAL	WIRE COLOR	DESTINATION
Shielded Wires; All Shields Connect to E5		
E1	Green	J1 – Pin 11
E2	Red	J1 – Pin 9
E3	Blue	J1 – Pin 12
E4	Brown	J1 – Pin 8
E5	Yellow	J1 – Pin 10
E6	Orange	J1 – Pin 7
Rotary Transformer Leads; Phasing Not Critical		
E7	Bare – Solid	T5 – 1
E8	Bare – Solid	T5 – 2
E15	Bare – Solid	T6 – 1
E16	Bare – Solid	T6 – 2

NOTE

The scanner cover is labeled. Orient it to the scanner according to the label before securing with screws (3).

3-161. AST Brush Replacement. AST brushes (Ampex Part No. 14622) have a long life expectancy and should not (under normal operating conditions) require replacement. However, if they become broken, damaged, or contaminated, they may be changed using the procedure below.

1. Remove scanner assembly from transport using the *Scanner Removal and Replacement* procedure, paragraph 3-158.

2. Install scanner service leg assembly onto the scanner. With rear of scanner facing upward,

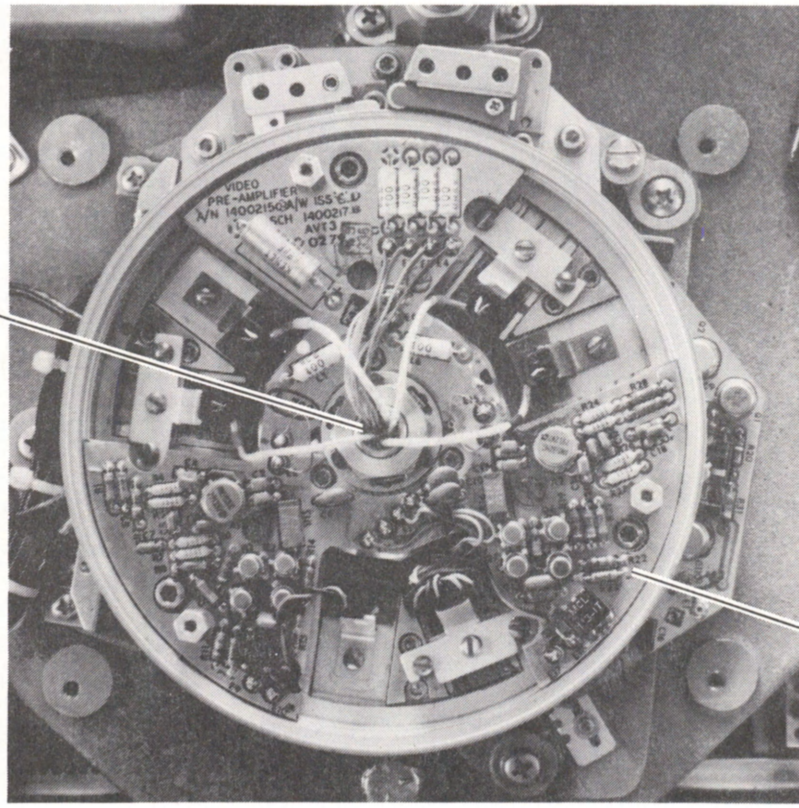


Figure 3-102. Scanner Assembly, Preamplifier PWA Removal

remove two 6-32 screws securing motor cover (Figure 3-99) to drum adapter plate. Remove cover.

3. Loosen the two 8-32 setscrews (Figure 3-103) securing the brush housing to the mounting stud. Gently slide the housing up the stud and free of the slip ring, allowing the brushes to snap together (see Figure 3-104).

4. One by one, withdraw each of the six brush retaining springs to expose the ends of the associated brushes. Slide the old brushes out and replace with new carbon brushes "V" grooved end out. Press the brush retaining spring(s) back into place over the brush ends. Examine each brush to verify that the spring wire is resting in the "V" groove in the end of the brush.

5. Mate the brush separator tool (Ampex Part No. 1408197) to the brush housing locator tool (Ampex Part No. 1408148) as shown in Figure 3-105. Starting at top-most brush, gently introduce the tip of the brush separator tool between the brush ends and insert tool further to separate all brushes (Figure 3-105 and 3-106). Push the tool further until the brush separator fully protrudes from the end of the brush housing and the head of the locator tool is flush against the brush housing.

Scanner motor
Brush Ass'y
1461442-AA0 (BLACK)
1461442-AB0 (RED)

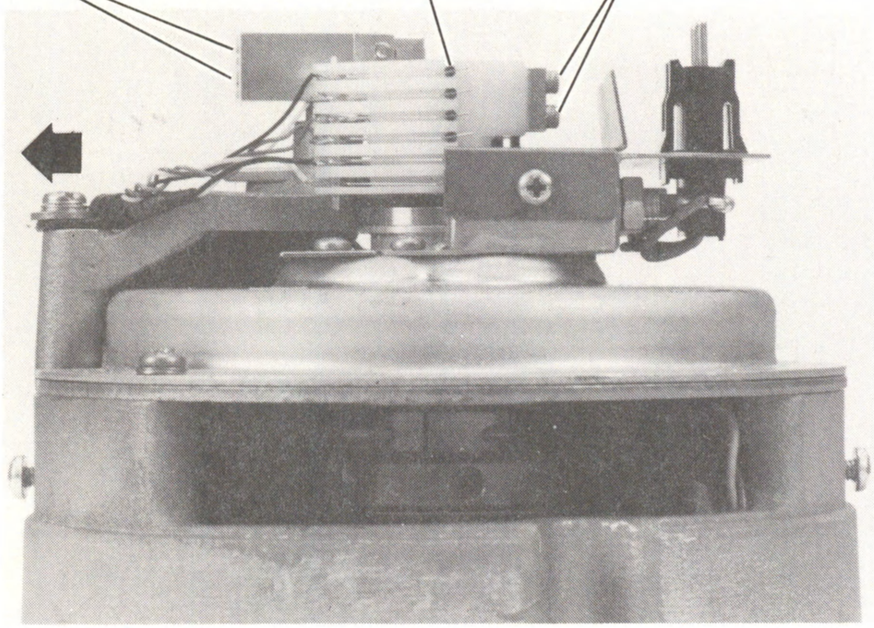


Figure 3-103. AST Brush Replacement

6. Secure the locator tool to the brush housing assembly using three 4-40 screws as shown in Figure 3-107. Slide out the brush separator from the locator tool. Verify that all brush springs are engaging the brush "V" grooves.

7. Inspect the slip rings closely to ensure that there are no scratches, nicks, grooves, or contamination on the soft silver slip rings. The presence of any of these factors may cause picture degradation caused by arcing. If cleaning is needed, clean the slip rings using a moderate amount of alcohol on a soft cloth. Remove all residue gently.

CAUTION

USE EXTREME CARE NOT TO BANG, SCRAPE, OR OTHERWISE DAMAGE THE PRECISION SURFACE OF THE SOFT SILVER SLIP RINGS. EVEN A MINOR NICK CAN CAUSE ARCING WHICH MAY AFFECT PICTURE QUALITY.

8. Orient the brush housing assembly as shown in Figure 3-104 aligning the locator tool bore over the top end of the slip ring assembly. Slide the tool/brush housing down over the slip rings (aligning the mounting hole over the mounting stud) until the brush housing is firmly seated with the top of the slip ring resting against the stop internal to the locator tool.

9. Tighten the two 8-32 mounting setscrews (Figure 3-104) to secure the brush housing assembly in place.

10. Remove the locating tool from the brush assembly (remove screws).

11. Inspect the brush springs to ensure that they are all in the groove of the brushes. Verify that all brushes contact the slip ring at the center of the silver ring area. Verify that the slip ring is at or very near the center of the brush housing (Figure 3-108).

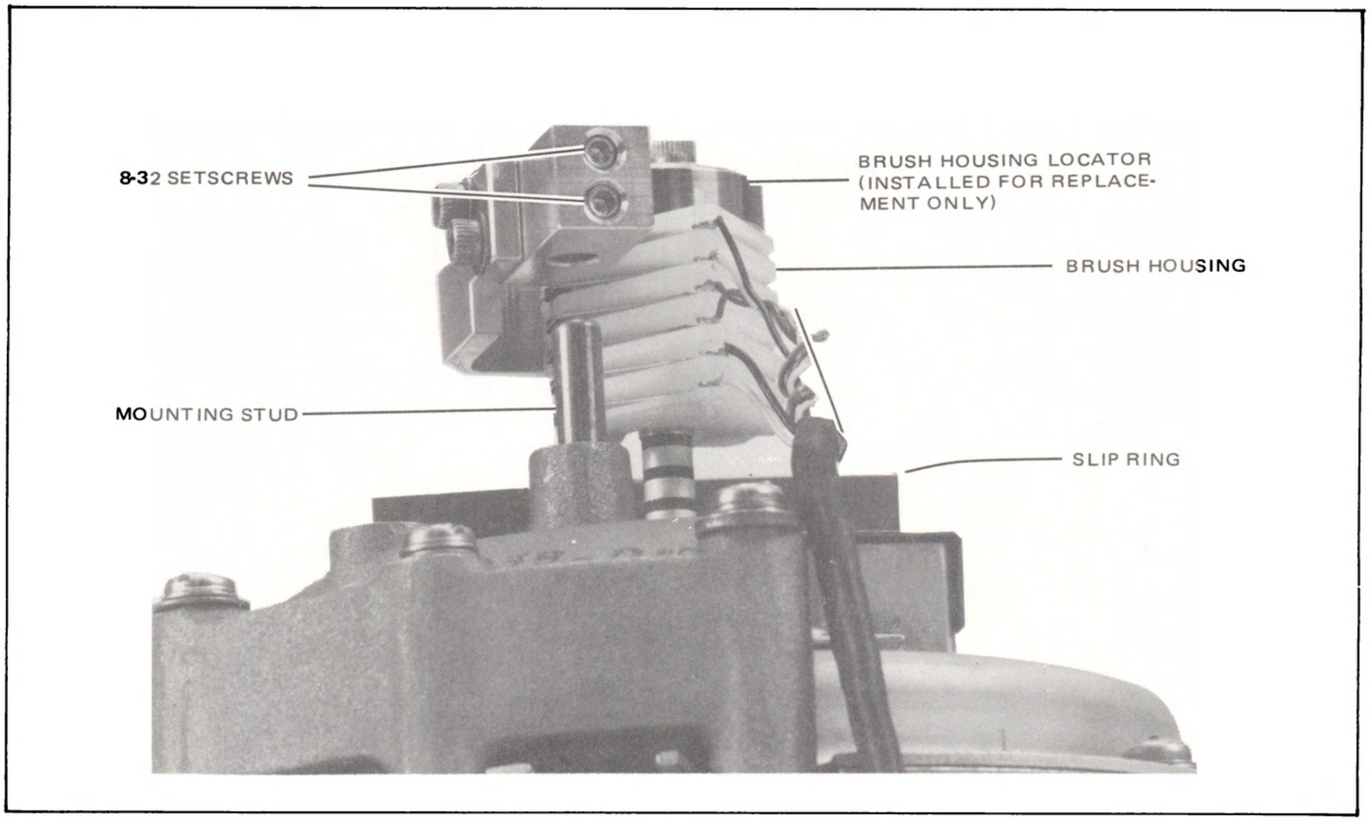


Figure 3-104. AST Brush Housing Removal and Replacement

12. Remove scanner service leg assembly. Reinstall scanner motor cover removed in step 2.

13. Reinstall scanner assembly into transport as described in the *Scanner Removal and Replacement* procedure, paragraph 3-158.

3-162. Slip Ring Assembly Replacement. Like the AST brushes, the slip ring assembly has a long life expectancy and should normally not require replacement. However, minor nicks, grooves, or other damage to the soft silver rings can cause arcing which can affect picture quality. In such a case, replacing the slip ring assembly may be indicated.

The slip ring assembly (Figure 3-104) is mounted on top of the collar adapter. Three sets of shielded connecting wires feed from it, through the center of the scanner assembly and connect to terminals on the Preamplifier PWA. This PWA is located on the upper (rotating) drum of the scanner assembly (Figure 3-102). Replace the slip ring assembly using the procedure below. A dial indicator is required for this procedure.

1. Remove scanner assembly from transport using the *Scanner Removal and Replacement* procedure, paragraph 3-158.

2. Remove the brush housing assembly using the *AST Brush Replacement* procedure, paragraph 3-160, steps 2 and 3.

CAUTION

WHILE PERFORMING THE STEPS BELOW, ALLOW NO TOOL OR PART TO CONTACT THE SOFT SILVER RINGS ON THE SLIP RING ASSEMBLY OR DAMAGE MAY RESULT WHICH COULD IMPAIR OPERATION.

3. Remove the three 4-40 panhead screws securing the slip ring assembly to the collar

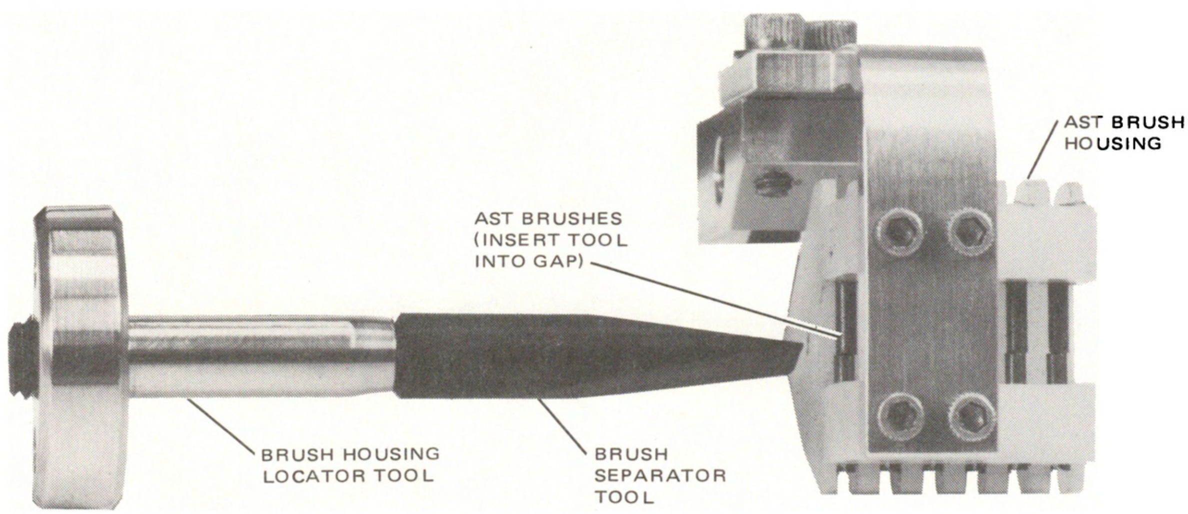


Figure 3-105. Separating the Brushes

adapter. Put motor cover back on the scanner temporarily.

4. Invert scanner so that the rotating drum is facing upward. Remove the drum cover (three screws).

NOTE

Note position of drum cover with respect to scanner. It must be replaced in exactly this position.

5. Unsolder slip ring wires from Preamplifier PWA terminals.

6. Tilt scanner sideways and remove motor cover. Carefully remove the slip ring assembly with connecting wires from the scanner.

7. Compare wire length between the new slip ring assembly and the old. If necessary, trim leads of the new assembly to match those of the old (lead length must be duplicated to ensure that critical scanner balance is retained).

8. Thread the six wires of the new slip ring assembly up through the scanner core to the Preamplifier PWA. Continue threading until the slip ring assembly base mates with its mounting surface on the scanner (it may be helpful to temporarily place a piece of tubing over all wires to facilitate threading them through the scanner, remove tubing before soldering leads in place).

9. Solder slip ring assembly leads to Preamplifier PWA terminals. Refer to the *Preamplifier PWA Parts Replacement* procedure, paragraph 3-159, step 5 for a listing of lead colors and terminal numbers. Do not use excessive solder.

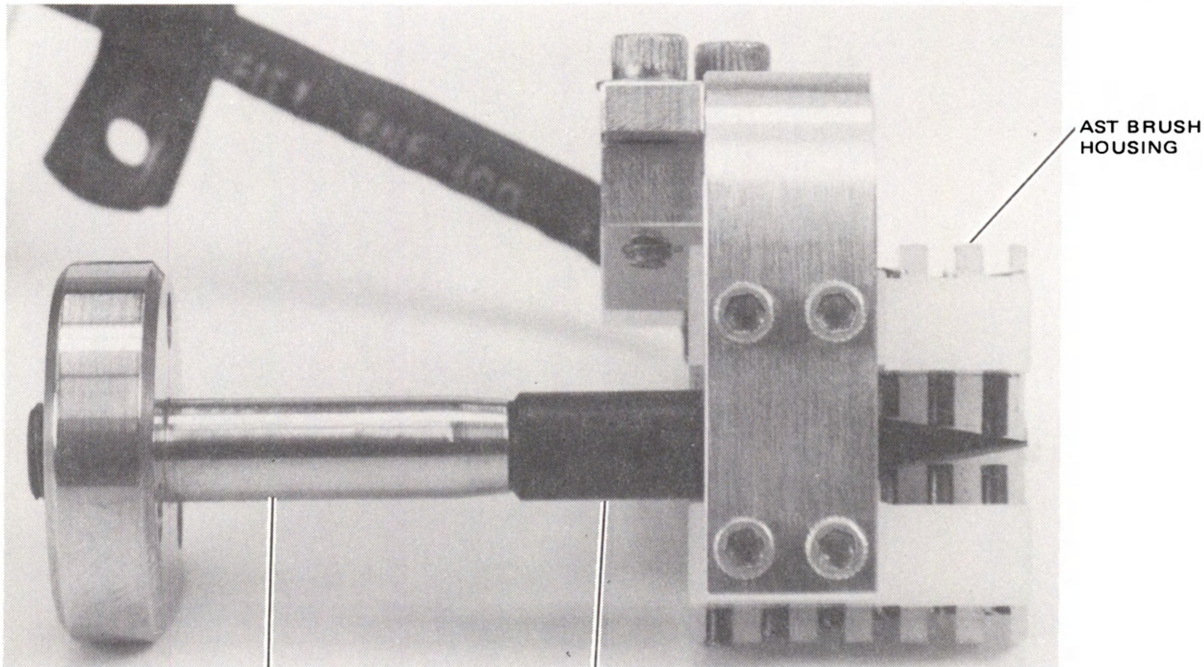


Figure 3-106. Separating the Brushes — Tool Partially Inserted

10. Replace scanner top cover in its proper orientation.

11. Invert scanner and insert three 4-40 screws that secure the slip ring assembly — tighten loosely.

12. Mount the Starrett 711-HS dial indicator and indicator support as shown in Figure 3-109 and Figure 3-110.

13. Locate the indicator tip at the center of number 1 ring and adjust or rotate for half scale indication.

14. Rotate the scanner and observe the indicator for reading. If greater than 0.001 run out, the slip ring must be recentered to be concentric. This can be accomplished by light tapping at the slip ring base, Figure 3-109.

15. Tighten the three slip ring mounting screws and recheck for concentricity. If it is more than 0.001 run out, loosen the mounting screws and repeat step 14. The slip ring assembly should be cleaned with alcohol after it is installed.

16. Replace brush housing assembly onto scanner. Mate the brush separator tool (Ampex Part No. 1408197) to the brush housing locator tool (Ampex Part No. 1408148) as shown in Figure 3-105. Starting at top-most brush, gently introduce the tip of the brush separator tool between the brush ends and insert tool further to separate all brushes (Figures 3-105 and 3-102). Push the tool further until the brush separator fully protrudes from the end of the brush housing and the head of the locator tool is flush against the brush housing. Verify that all brush springs are engaging the brush "V" groove.

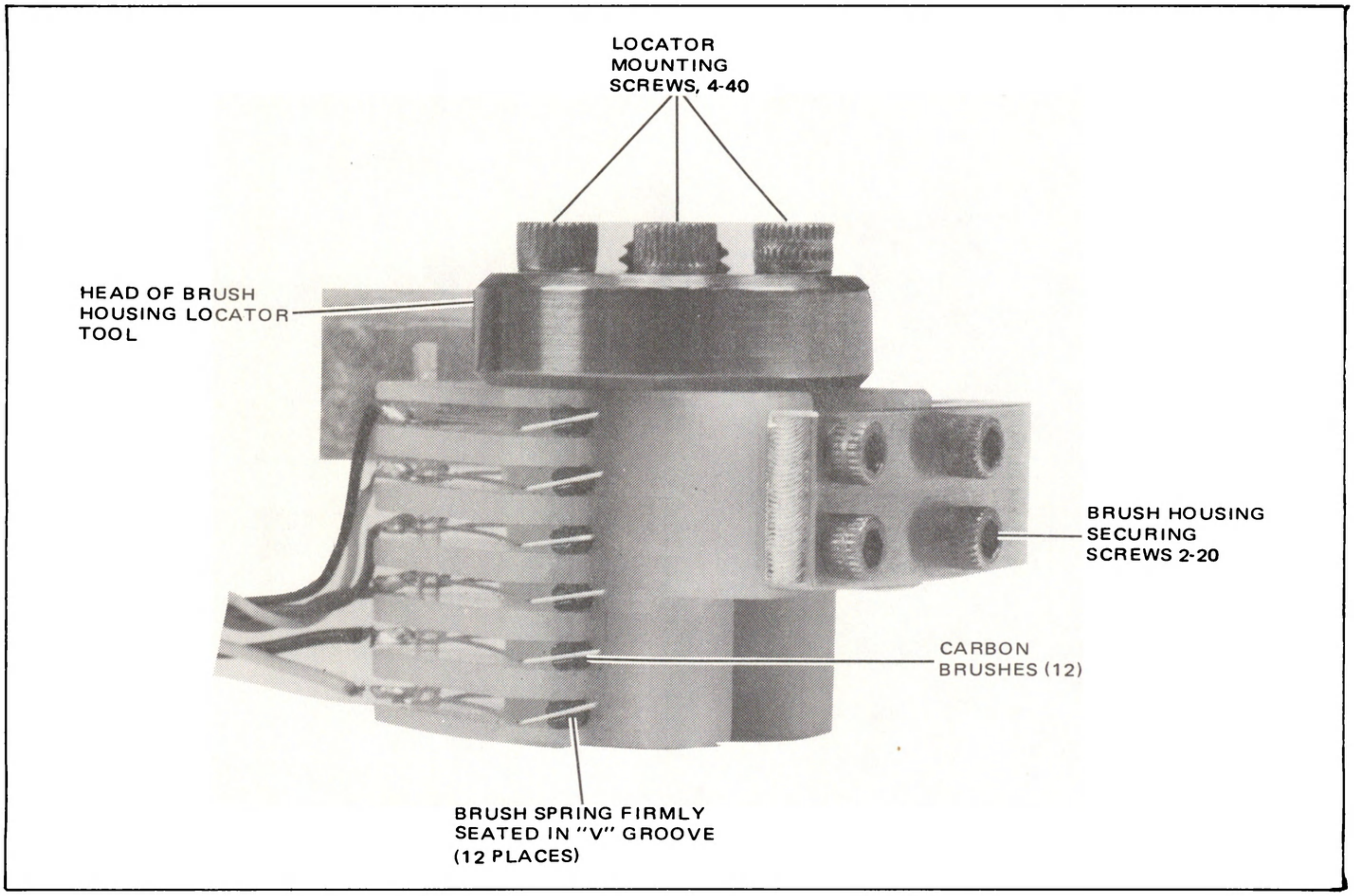


Figure 3-107. Brush Housing Locator Mounted Onto Brush Housing

17. Secure the locator tool to the brush housing assembly using three 4-40 screws as shown in Figure 3-107. Slide out the brush separator from the locator tool.

18. Inspect the slip rings closely to ensure that there are no scratches, nicks, grooves, or contamination on the soft silver slip rings. The presence of any of these factors may cause picture degradation caused by arcing. If cleaning is needed, clean the slip rings using a moderate amount of alcohol on a soft cloth. Remove all residue gently.

CAUTION

USE EXTREME CARE NOT TO BANG, SCRAPE, OR OTHERWISE DAMAGE THE PRECISION SURFACE OF THE SOFT SILVER SLIP RINGS. EVEN A MINOR NICK CAN CAUSE ARCING WHICH MAY AFFECT PICTURE QUALITY.

19. Loosen the four 3-56 brush housing securing screws and the two 4-40 brush housing securing screws so that the brush housing can properly self-align itself when installed (Figure 3-108).

20. Orient the brush housing assembly as shown in Figure 3-104 aligning the locator tool bore over the top end of the slip ring assembly. Slide the tool/brush housing down over the slip rings (aligning the mounting hole over the mounting stud) until the brush housing is firmly seated with the top of the slip ring resting against the internal stop of the locator tool.

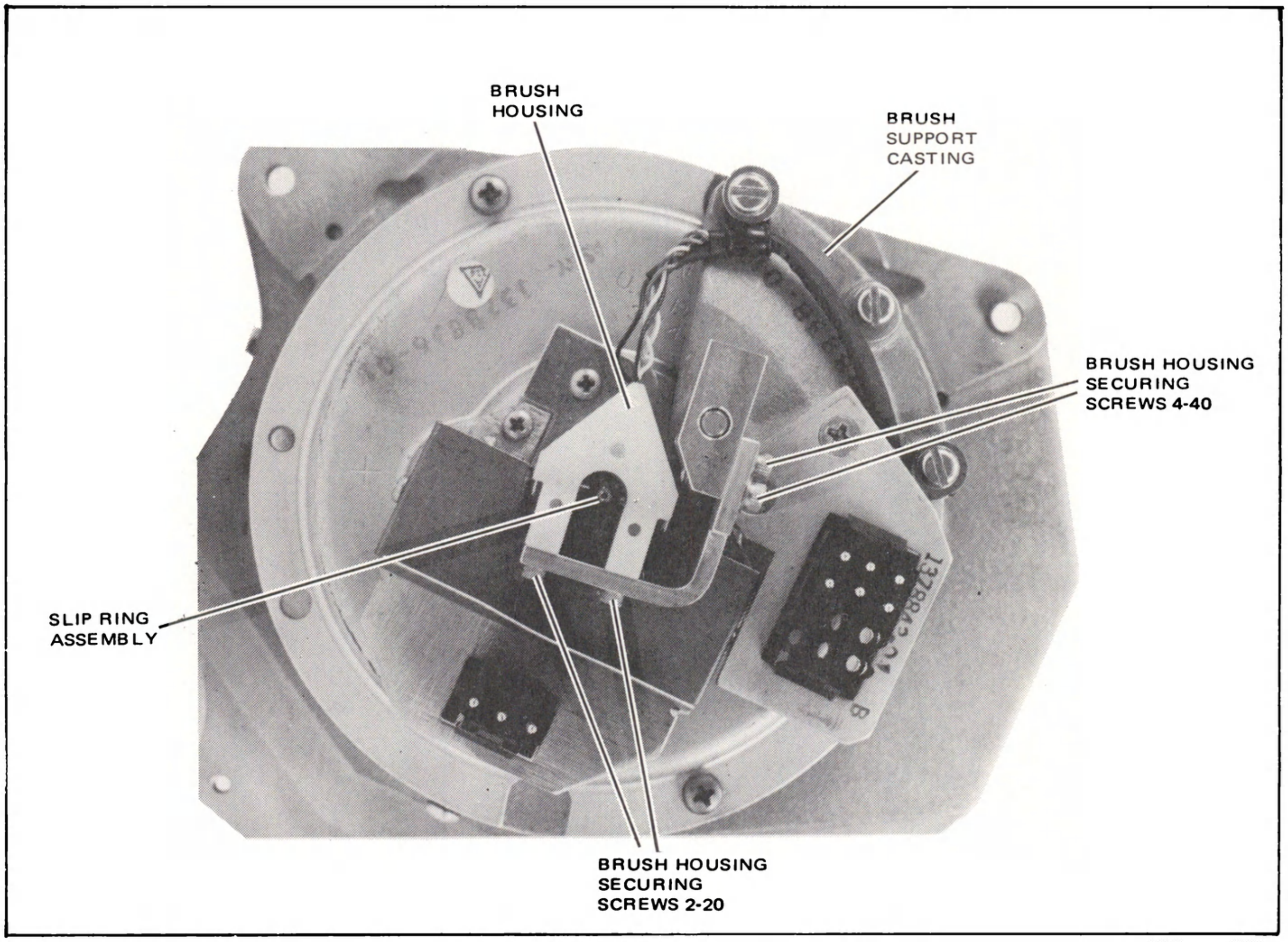


Figure 3-108. Proper Brush Housing Centering

21. With brush housing properly seated, snug up the two 4-40 and two of the four 2-56 brush housing mounting screws – do not tighten.

22. Tighten the two 8-32 setscrews to secure the brush housing clamp to the mounting stud. Once this is done, tighten the remaining mounting screws (four 2-56's and two 4-40's).

23. Remove the three screws securing the brush locating tool to the brush housing and remove the tool.

24. Inspect the brush springs to verify that they are all in the "V" groove of the brushes. Verify that all brushes contact the slip ring at the center of the silver ring area. Verify that the slip ring is at or very near the center of the brush housing (Figure 3-108).

25. Reinstall scanner motor cover. Remove scanner service leg assembly.

26. Reinstall scanner assembly into transport in the manner described in the *Scanner Removal and Replacement* procedure, paragraph 3-158.

3-163. Scanner Motor Brush Replacement. To replace the scanner motor brushes (Ampex Part No. 7356040) located within the brush plate assembly, proceed as follows:

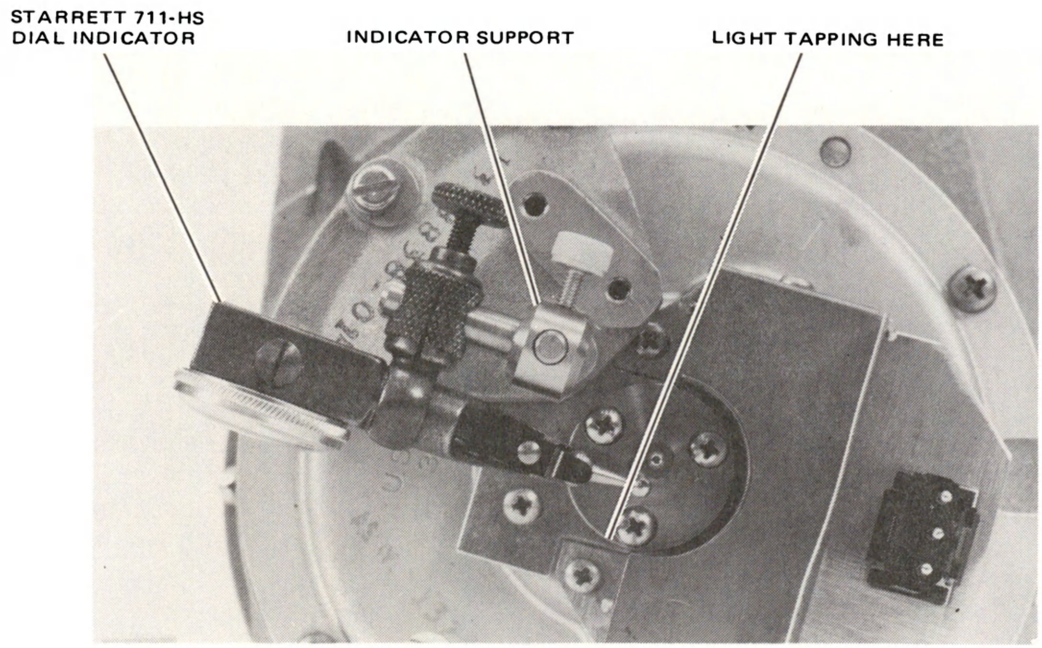


Figure 3-109. Dial Indicator and Support Mounted on Scanner

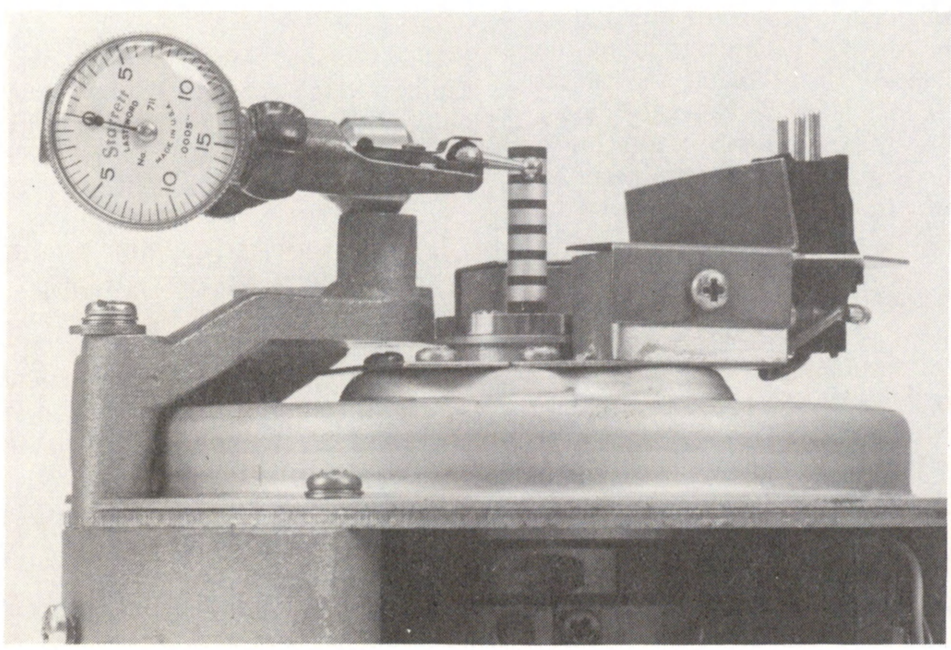


Figure 3-110. Measuring Slip Ring Runout

1. Remove the AST brush housing from the scanner using the *AST Brush Replacement* procedure, paragraph 3-160, steps 1 through 3.

2. Remove three slot-head securing brush support casting to the scanner (Figure 3-108). Set the casting aside.

3. Remove two No. 4 screws securing printed motor plate shield to brush support plate. Remove shield.

4. Remove two 6-32 screws that mount brush plate assembly to spacer and motor front plate.

CAUTION

DURING NEXT STEP, PULL MOTOR BRUSH PLATE STRAIGHT UP FROM MOTOR HOUSING - DO NOT SLIDE LATERALLY OR ROTOR DAMAGE MAY OCCUR. DO NOT SCRATCH OR TOUCH PRINTED MOTOR ROTOR SURFACE, ESPECIALLY IN COMMUTATOR AREA.

5. The permanent magnet within the brush plate assembly (Figure 3-111) tends to hold the plate to the motor front plate. Use a flat bladed screwdriver placed between the motor front plate and the raised tab in the brush plate assembly to carefully pry the plate up from the motor front plate. Then remove the brush plate assembly.

CAUTION

ALLOW NO METALLIC PARTICLES TO GATHER ON THE PERMANENT MAGNET.

6. Unsolder each brush lead and remove brushes. Save brush springs.

7. Install new brushes and existing springs. Before soldering brush leads, adjust lead length so spring does not force brush from brush holder. While soldering lead, clamp brush lead with a long-nose pliers to prevent solder from entering braid.

8. Contour brush ends by placing the rear cover face down on a sheet of 400-grit silicon-oxide sandpaper placed on a hard flat surface. Rotate the rear cover clockwise two to three revolutions. Clean all contamination from magnet and clean brushes with isopropyl alcohol. Remove all residue. Let brushes dry.

9. Clean rotor surface with isopropyl alcohol. Remove all residue.

10. Carefully reinstall brush plate assembly onto front plate and position over the front plate centering identations. Secure brush plate assembly with screws removed in step 4.

11. Reinstall printed motor plate shield onto brush plate. Secure with two screws removed in step 3.

12. Replace brush support casting removed in step 2.

13. Reassemble scanner and replace scanner in VPR. Perform steps 5 through 13 of the *AST Brush Replacement* procedure, paragraph 3-160.

3-164. Scanner Motor Rotor Replacement Procedure. Read this procedure through completely before commencing. Proceed as follows:

CAUTION

DYNAMIC SCANNER BALANCE, AS ACHIEVED AT THE FACTORY, IS CRITICAL. REMOVING AND REPLACING THE SCANNER MOTOR ROTOR DEGRADES THIS BALANCE. SCANNER IMBALANCE CAN CAUSE VIDEO DETERIORATION AND (POSSIBLY) SCANNER DAMAGE. PERFORM THIS PROCEDURE ONLY IN AN EMERGENCY, AND ONLY WHEN AMPEX SERVICE IS NOT AVAILABLE.

1. Remove the scanner assembly from transport, and remove the brush plate assembly from the scanner assembly by performing steps 1 through 7 of the *Scanner Motor Brush Replacement* procedure, paragraph 3-162.

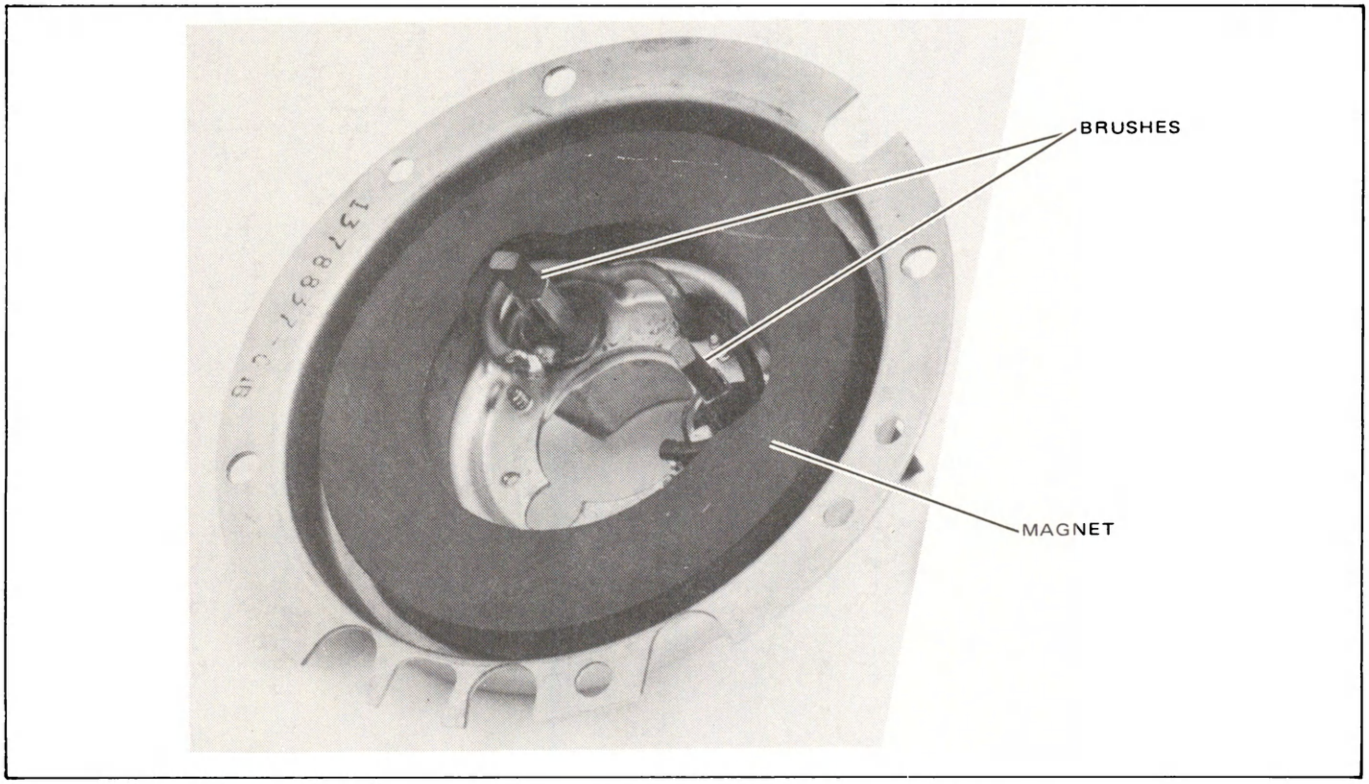


Figure 3-111. Scanner Motor Brush Plate Assembly, Rear View

2. Remove the slip ring assembly by performing the *Slip Ring Assembly Replacement* procedure, paragraph 3-161, steps 2 through 6.

CAUTION

REMOVING OR REPLACING THE SCANNER MOTOR ROTOR AFFECTS CRITICAL SCANNER BALANCE. THIS PROCEDURE IS APPROPRIATELY DONE AT AN AMPEX SERVICE FACILITY ONLY. IF IT IS REMOVED IN THE FIELD (AS UNDER EMERGENCY CONDITIONS), GREAT CARE MUST BE TAKEN TO RECORD AND RESTORE ROTOR BALANCE SETTINGS AS CLOSELY AS POSSIBLE TO ORIGINAL (FACTORY) BALANCE CONDITION.

3. Using a small scribe, gently mark one of the three slip ring assembly mounting holes of the collar adaptor. Gently mark an adjacent portion of the exposed shaft to establish an exact azimuth (rotational) reference for the new rotor. The scribe lines (near the hole and on the shaft) should meet to give precise alignment reference.

4. Loosen the two 4-40 socket-head rotor hub mounting screws (Figure 3-112) securing rotor hub to collar adaptor. Remove the rotor with collar.

5. Place the old and new rotors side by side on a piece of paper. Align the two so they face the same way. Mark the same slip ring mounting hole of the new rotor exactly in the same manner as was done to the old rotor.

6. Using a depth gauge, measure the depth or protrusion of each of the four balance set screws of the old rotor collar (Figure 3-112). Record the value of each measurement taken on the paper immediately below each balance setscrew.

7. Swap the two rotors so that the new rotor is resting on the sketch of the old rotor, with

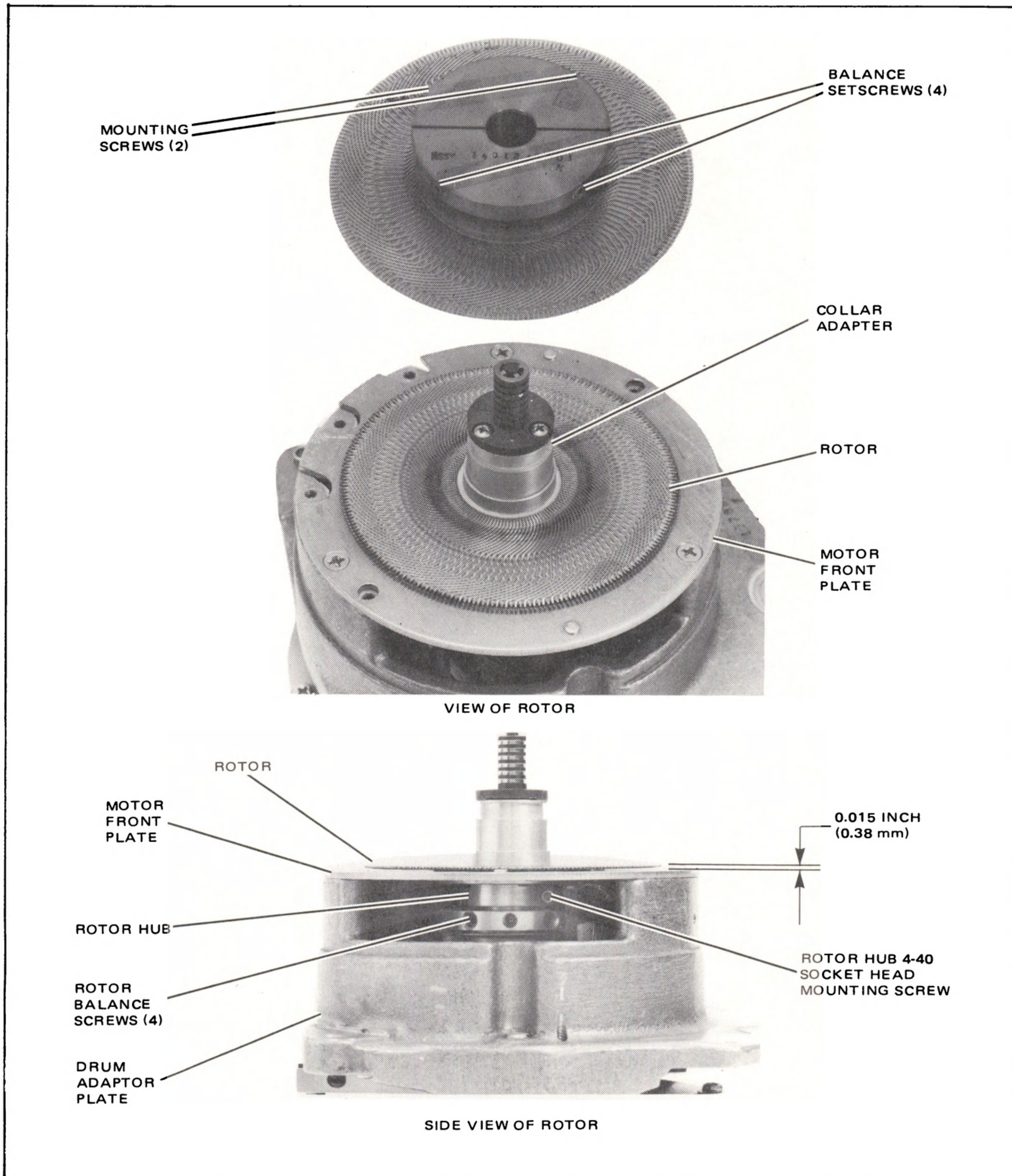


Figure 3-112. Scanner Motor Rotor Replacement

the measurements (on the paper) below the appropriate holes of the new rotor.

8. One by one, remove the setscrews from the old rotor and transfer them to the new rotor. Install them to the exact depth or protrusion value recorded on the paper. Put a small dab of thread seizing compound on each setscrew before installing.

9. Clean the new rotor assembly with isopropyl alcohol. Remove all residue. Do not touch or otherwise contaminate brush contact area after cleaning.

10. Install new rotor collar on the motor shaft in the exact same azimuth position as the previous rotor. Refer to the scribe marks, and to the sketch made earlier.

11. Use a feeler gauge to establish a gap of 0.015 inch ±0.005 inch (0.38 ±0.12 mm) between the rotor and the motor front plate, as shown in Figure 3-112. Tighten the two rotor hub mounting screws loosened in step 4.

12. Reassemble the scanner and reinstall it into the VPR by performing the *Slip Ring Assembly Replacement* procedure, paragraph 3-161, steps 7 through 26.

3-165. Tach PWA Replacement. To replace the Tach PWA, shown in Figure 3-113 (Ampex Part No. 1401280), proceed as follows:

1. Remove scanner assembly from transport as described in the *Scanner Assembly Removal and Replacement* procedure, paragraph 3-157.

2. Install scanner service legs on scanner. With scanner inverted, remove two 6-32 screws securing motor cover (Figure 3-99) to drum adapter plate. Remove cover.

3. Loosen Tach PWA mounting screw (Figure 3-113). Slide Tach PWA outward so screw is free of slot. Move the assembly to the right (approximately 1/2 inch) to center the mounting screw in the large slot. Withdraw the Tach PWA by gently tilting and drawing outward — free of the scanner assembly. Reposition the attached wires as required to afford adequate clearance.

4. Unsolder leads from Tach PWA.

5. Install new Tach PWA. Solder leads removed in step 4 to new Tach PWA as follows:

TACH PWA TERMINAL	WIRE COLOR	DESTINATION
E1	Red	Terminal 4
E2	White/Red	Terminal 1
E3	White/Black	Terminal 2
E4	Black	Terminal 3

6. Insert new Tach PWA into scanner assembly. Follow the reverse order of step 3 above. Seat Tach PWA firmly into mounting slot and press it firmly against the two roll pins protruding through the motor front plate. Tighten mounting screw.

3-166. Postamplifier PWA Replacement. The Postamplifier PWA (Figure 3-114) resides in the lower (stationary) portion of the scanner assembly. It may be removed without disassembling the scanner assembly. Remove as follows:

1. Remove VPR power.

2. Remove standoff immediately below the bottom left-hand corner of the takeup reel motor count casting.

3. Extract Postamplifier PWA from scanner assembly. Pull on exposed PWA edge (Figure 3-114) opposite connector. Do not use excessive force.

4. Reinsert Postamplifier PWA. Align connector edge of board with board guides and insert gently. Once inserted, mate the PWA firmly with its connector.

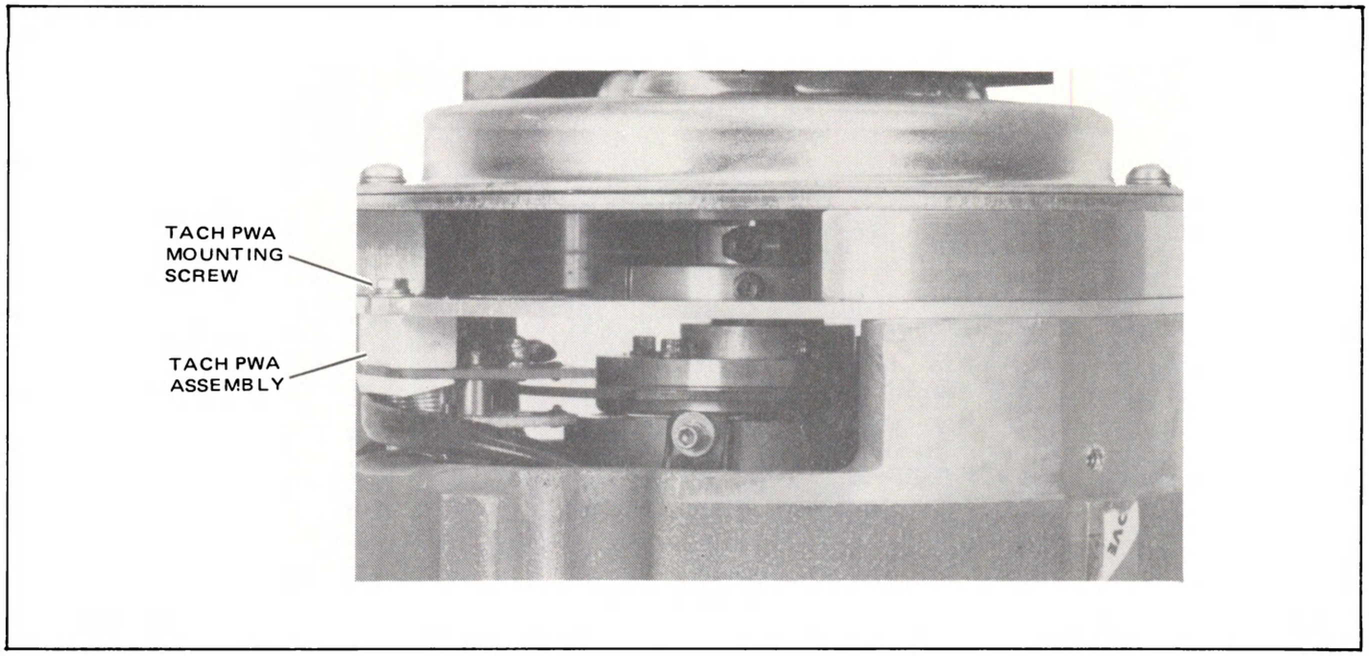


Figure 3-113. Tach PWA Removal

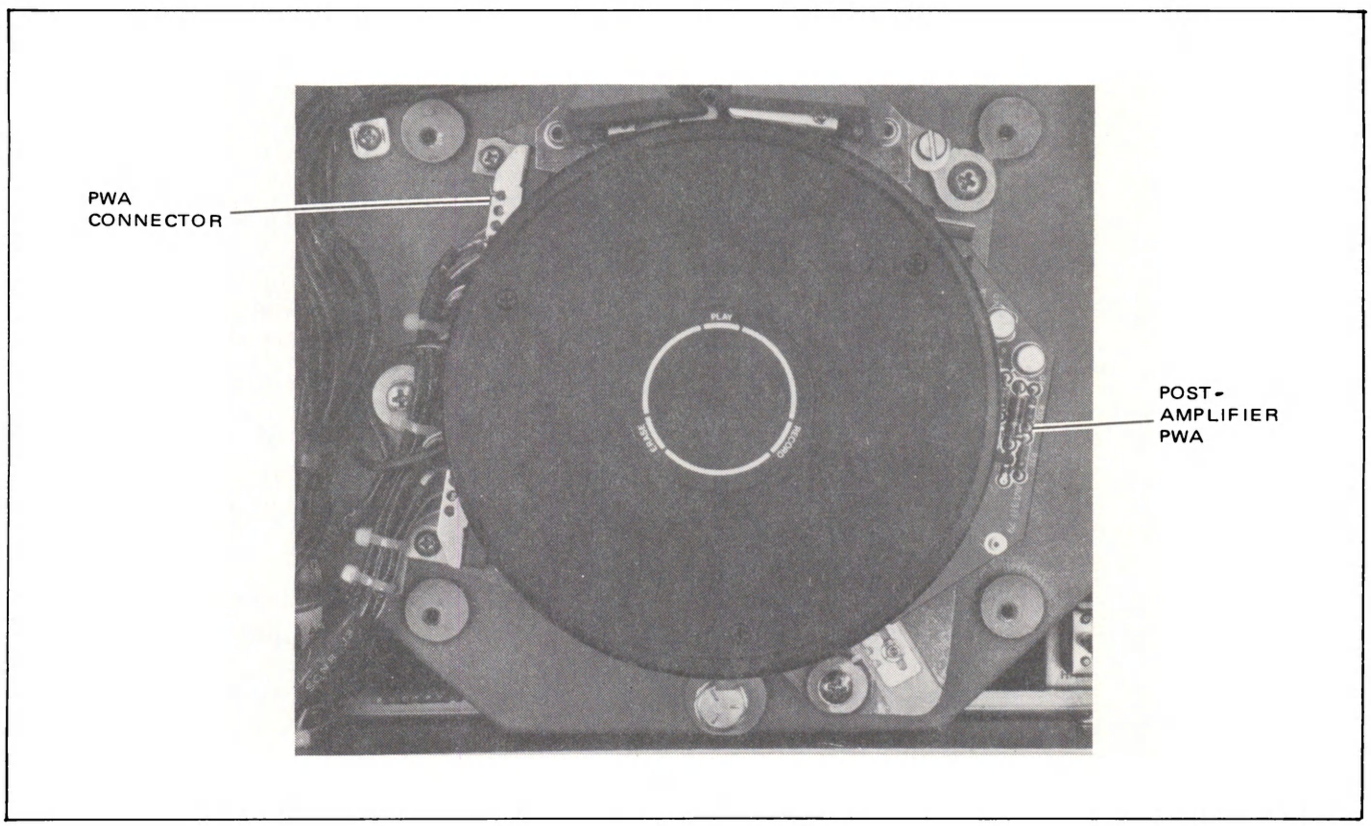


Figure 3-114. Postamplifier PWA Removal

5. Replace standoff removed in step 2.

3-167. Flutter Idler Assembly and Parts Replacement. The flutter idler assembly and flutter idler brake assembly should normally not require replacement nor lubrication (since the bearings are permanently lubricated). If this assembly is damaged or needs removal to allow access to other transport components, proceed as follows:

1. Remove VPR power and unplug power cord. Remove rear panel and remove transport trim (paragraph 3-8) to expose the flutter idler. Remove exit guide cover.

2. Remove two phillips-head screws securing MDA PWA and swing PWA out of the way.

3. Remove eight phillips head screws securing the MDA and regulator heat sink assemblies (Figures 3-28) and pull both heat sink assemblies aside to expose the transport underside.

4. Remove two No. 8 socket-head cap screws securing flutter idler brake assembly to transport (Figure 3-115). Allow assembly to hang. This exposes the flutter idler flywheel.

5. Remove shaft with flywheel. At front of machine, remove keeper from flutter idler shaft. At rear of machine, pull flywheel with shaft out of transport. Loosen setscrew in flywheel to separate it from the shaft.

6. Remove stanchion. Remove two screws securing stanchion to transport. Note that the stop for the right-hand longitudinal head assembly must be temporarily removed to allow access to the right-hand stanchion securing screw.

7. Replace flutter idler assembly. Install stanchion using screws removed in step 6. Orient stanchion so that the stop may be replaced on the right side. Install stop flush against longitudinal head assembly after stanchion is installed.

8. Install shaft with flywheel. Mate flywheel to shaft before installation. Install shaft in reverse order of removal (step 5).

9. Replace brake assembly removed in step 4. Press solenoid plunger (not the linkage) to manually activate brake. Verify that 0.015-inch (0.40 mm) or greater clearance exists between the brake (O-ring) and the flywheel with the brake activated. Loosen brake assembly mounting screws and move the assembly (in slotted holes) as required to achieve the required clearance. Tighten screws and recheck clearance.

10. At front of machine, spin the flutter idler with fingers to ensure that it spins freely and with no noise. Spin both directions.

11. Replace MDA and regulator heat sink assemblies removed in step 3.

12. Swing MDA PWA back into position and replace screws removed in step 2.

13. Replace exit guide cover, skins, and rear panel removed in step 1.

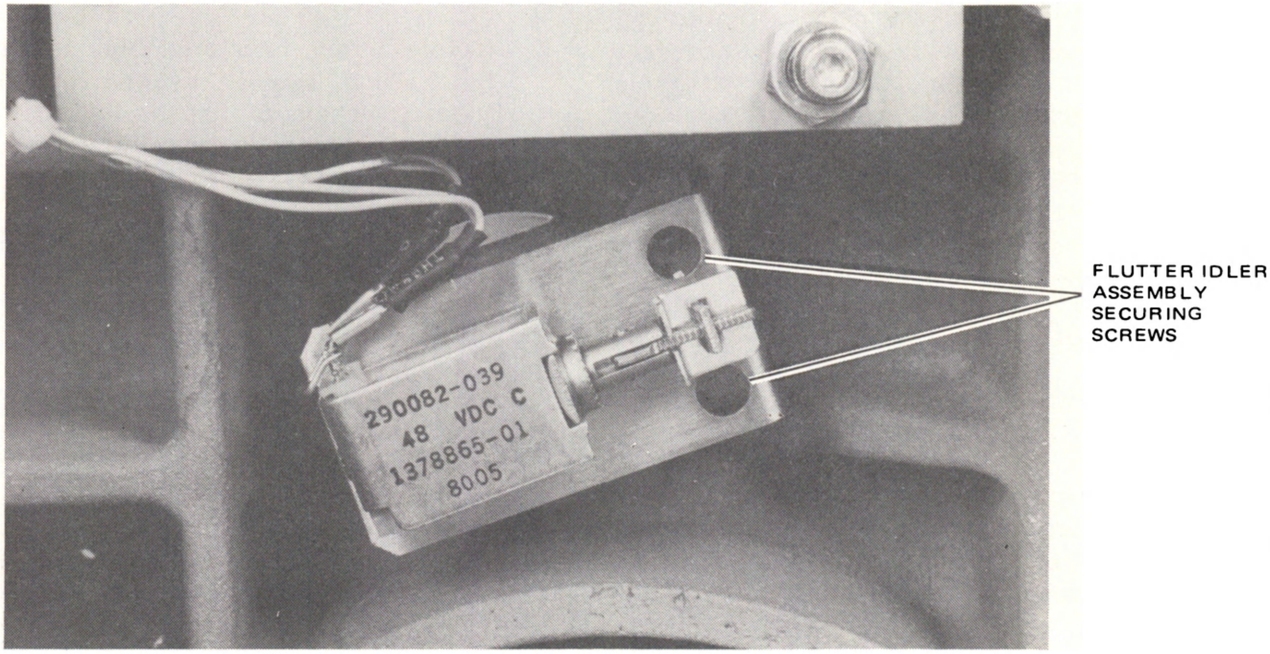


Figure 3-115. Flutter Idler Assembly and Parts Replacement